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THE PRESENT RAILWAY SITUATION IN SYRIA AND PALESTINE.

We are indebted to the courtesy of Mr. G. Bie Ravndal, U. S. Consul at Beirut, Syria, for the following interesting material relating to the present railway situation in Syria and Palestine, and for the photographs used in illustrating the same. The development of the Hauran wheat region and the gradual introduction of American agricultural machinery are especially worthy of note.

The first railway constructed in Palestine connected the seaport of Jaffa with Jerusalem, and was officially opened to traffic on Sept. 26, 1892, with imposing Oriental ceremonies. This line was suggested as early as 1864 by Dr. Charles F. Zimpel, a citizen of the United States; and it was built upon American lines and is now operated by locomotives constructed by the Baldwin Locomotive Works. It is managed, however, by a French company. As originally planned by Dr. Zimpel, this Jaffa-Jerusalem railway project included branch lines to Gaza, Nablous, Jericho and the Dead Sea, and an extension of the main line up the Valley of the Jordan and thence east to Damascus; but these plans were never carried out.

On Aug. 3, 1895, a French syndicate inaugurated the Beirut-Damascus Railway, and this line has now been extended from Damascus south to Mzerib, and has two branch lines to Tripolis and to Homs. This railway and that connecting Jaffa and Jerusalem are the only railways now actually operated in Syria and Palestine.

It now appears that the Turkish government proposes to build its own railways; very probably, with the assistance of foreigners in the initial operations; but with the ultimate control to be centered at Constantinople. It is doubtless in pursuance of this policy that the Turks have recently bought back from an English syndicate the concession granted for the construction of a railway starting at Haifa, on the Mediterranean coast.

This line would tap the Hauran, the granary of Syria, now skirted on the east by the Damascus-Mzerib Railway. Owing to heavy port charges at Beirut and to the relatively high freight rates, camels are still able to compete with the Beirut-Damascus-Mzerib railway. Passing from Jolan to Akka, on the coast, from 4,000 to 6,000 camels, each with a load of 500 lbs. of grain, daily traverse the road leading from the interior to the sea. These camels carry Hauran wheat, barley and corn, but as the camel driver claims half the load as his reward, and the farmer has to pay for the seed, taxes, etc., the latter receives a scant compensation for his labor. American agricultural machinery is being gradually introduced into the Hauran, and with the aid of the railways now under construction there will be a marked change in conditions at some future time.

AN ARAB SHEIKH.

These Camels Still Successfully Compete with Existing Railways in Syria.

As shown by the accompanying map, considerable work has already been done, not only on the road leading out from Haifa, but also on a railway practically following the old caravan road between Damascus and Mecca. These lines are being constructed by Turkish soldiers with money raised by popular subscription among Mohammedans in all parts of the world. The method is Oriental in its conception, but it is also very practical in its results, as a railway on this line would not only give aid and comfort to the pious contributors, but would also open up to commerce a fertile section of Syria that is now inaccessible for this purpose. It is lately reported that the Pennsylvania Steel Co. has closed a contract for supplying 20,000 tons of steel rails for the Mecca railway; the rails to be delivered at Beirut.

An inspection of the elevations noted on the maps shows that while the Beirut-Damascus line commences at the only protected harbor on the Syrian coast, the operation of this line is very costly owing to excessive grades on the Lebanon Mountains. The location of the Haifa-Damascus railway is much more favorable in this respect; but a harbor must be constructed at Haifa before the railway can properly compete with the older line.

As already remarked, American machinery is gradually being adopted by the more progressive among the Syrian farmers. They now use minor

American agricultural machinery, American oil motors and American windmills. Abdul Rahman Pacha, representing the Khalif as the manager of the Mecca pilgrimages, is the owner of large estates in Coele-Syria and the Hauran; and he has set a good example to his neighbors by importing from the United States, in July, 1903, a complete steam threshing plant, the second outfit of this type that has reached Syria. Now that the value of labor-saving machinery is being better understood, steps are being taken to reclaim thousands of acres of land now lying idle in the Hauran district, and with the completion of the Turkish railway system and a port at Haifa, a brighter future awaits Syria.

EXPERT OPINIONS ON THE BALTIMORE FIRE.

(Concluded from page 173.)

Sir: The Baltimore fire has demonstrated beyond any doubt the superiority and advantages of fireproof buildings. By fireproof buildings is meant the steel skeleton frame type, in which the steel work is protected by incombustible materials. These structures in all cases preserved their integrity, remained standing, and formed valuable barriers against the spread of the flames. Had there been a larger proportion of buildings of this type, there is little doubt but that the fire could have been controlled by the firemen and the great conflagration averted.

The combustible contents of all these buildings with one or two exceptions were, however, totally consumed. The spread of the flames to the upper stories of the high buildings and from one building to another was due entirely to the lack of protection at the window openings and the inflammable character of the window frames and sash.

The stone fronts of all the buildings exposed to the fire have been seriously damaged. Even the architectural terra cotta, which has heretofore been supposed to be an excellent material to withstand fire, failed in many places. Granite, limestone and marble spalled and scaled off, leaving disfigured fronts that will in most cases have to be restored in their entirety.

The material used to protect the steel skeleton frame and for floors and partitions can be divided into two classes; hollow blocks of terra cotta and lime-teil, and concrete. Generally speaking, these materials successfully protected the structural steel, there being only a few instances where columns were deflected or buckled by the heat. The exact amount of the damage to the steel frames and the fireproofing cannot, however, be determined until a careful detailed inspection and instrumental survey is made of each building.

As a matter of fact, the combustible contents of the fireproof buildings, which consisted of the wood floor finish, trim, furniture and furnishings, did not afford sufficient fuel to create a fire of sufficient duration to make a severe test of the fireproofing material. The high wind fanned the flames and generated a high temperature, the fusing of metals indicating temperatures of about 2,000° F.; but this temperature was probably not maintained for more than an average of 20 to 30 minutes at any given place. In other words, the fire was intense as long as the fuel lasted, the wind keeping the embers alive until every vestige of woodwork was consumed.

The condition of the fireproofing material is also much better than it would have been had water been thrown on it while at a high temperature, which invariably occurs under ordinary circumstances.

Comparing the efficiency of concrete and the hollow blocks as fireproofing materials, there is no doubt but that the concrete made from steam boiler cinders and Portland cement, made the best showing.

A careful personal inspection and study of the effects of this fire warrants the following conclusions and suggestions for the design of future buildings:

(1) The window openings having proved the vulnerable points for the fire, architects and engineers should give special attention to such openings and provide materials and devices which offer adequate resistance to fire from exterior attack.

(2) Common brick for exterior walls withstood the fire and heat better than any other material. The spalling and scaling off of all varieties of stone and terra cotta where exposed to intense heat would indicate that these are unsuitable for exterior work, and that a new and more refractory material is needed for exterior ornamentation.

(3) The destruction to stone columns and caps and bases demonstrated that this material is unsuitable for this purpose.

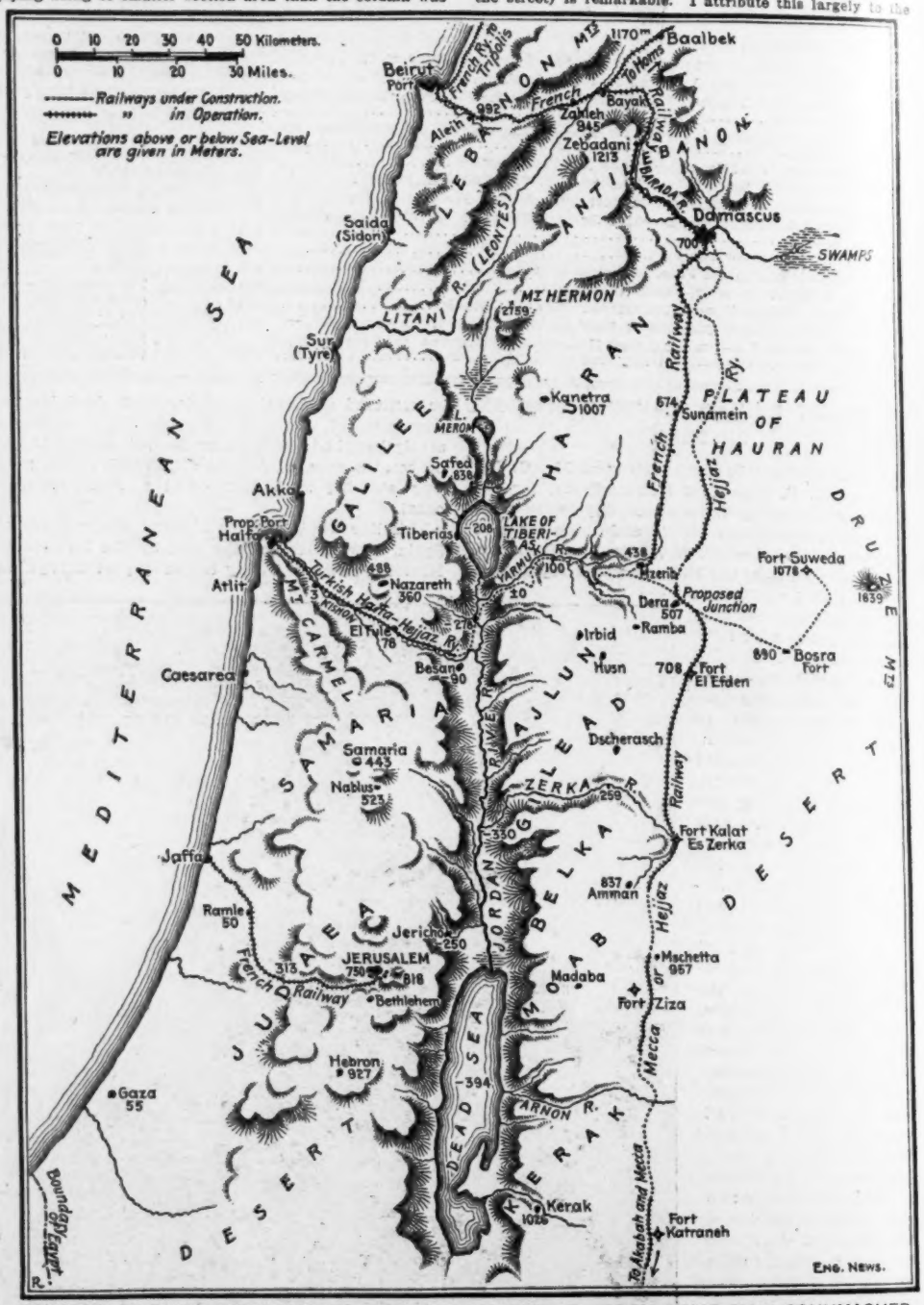
(4) Stairways should in all cases be provided with metal treads underneath the slate or marble wearing surface. In many cases marble treads were absolutely destroyed by the fire, leaving only the open frames in position.

(5) A system of fireproofing for the floors which is able to sustain safes, and which will not fall when objects of considerable weight fall upon it, should in all cases be used. The Equitable Building was an illustration of serious and extensive damage, caused by 20 or 30 falling safes, many of which fell from the top story carrying all the tile arches beneath with them in their course to the cellar. The safes in this building falling on beams, bent and distorted the steel work and jarred the entire skeleton frame of the building in many places.

(6) The pernicious custom of carrying pipe lines adjacent to and parallel with the lines of columns is without doubt the direct cause of the injury to the few columns that failed. The usual method was used; the piping and column being encased by hollow terra cotta blocks. The piping being of smaller section area than the column was heated more rapidly, expanded and forced away the terra cotta protection, leaving the columns exposed to the flames.

A. L. A. Himmelwright,

Fuller Building, New York City, Feb. 22, 1904.



PRESENT RAILWAY SITUATION IN SYRIA AND PALESTINE. FROM A MAP BY G. SCHUMACHER, PH.D., U. S. CONSULAR AGENT AT HAIFA, AUG. 1, 1903.

Sir: In complying with your request to report upon the Baltimore fire and conflicting statements concerning buildings and materials, I will confine myself to useful facts alone and to deductions based upon them and previous experience and tests.

It must be understood that I only refer to buildings which were really exposed to a severe ordeal, and that I use such words as "all" and "none" in a practical sense; that is, the exceptions to any such statement are too small to be of much importance.

All the contents of all buildings, ancient or modern, were completely destroyed, excepting the contents of good vaults and safes (which were not opened too soon), particularly those which were in the basements, or safes which fell into the cellars. Therefore so far as the tenants are concerned the so-called "absolutely fireproof buildings" were an absolute failure.

As for the owner of an old-fashioned building, he has but a pile of fallen walls, twisted pipe, broken columns and occasionally a dangerous wall or chimney; all useless and very expensive to remove.

The owner of a modern building, of skeleton construction, has a structure damaged 40 to 80% of its cost. The uniformity in the destruction of all contents, trim and ornamentation (throughout all stories above the level of the street) is remarkable. I attribute this largely to the fact that after the old buildings on the windward side of a skyscraper were consumed, the wind was heated by the radiation from the ruins (but not robbed of its oxygen), and set fire wherever it reached. The damage to the skeletons vary from almost nothing to say 10%; that is to say, columns, girders and beams requiring renewal and foundations injured by falling material.

The damage to "fireproof" floors varies still more. Much of it was due to slight faults in design, choice of material or ignorance or neglect in supervising the work of construction. As fire and water-resisting materials, terra cotta and concrete have given a very good account of themselves. The destruction of partitions is still more irregular, and as a rule they show want of stability in their construction.

Any one discussing the Continental Trust Co.'s building must remember that the materials in this building were not subjected to water from the fire engines.

The injury to the outside of buildings is very great, requiring all the way from an entire new front to extensive

renewals or repairs. The injury to the brick and bluestone in the Baltimore & Ohio Building is greater than any I have seen here or abroad. Wire glass has given a pretty good account of itself. The common iron shutter, metal covered doors and sash leave a good deal to be desired.

As regards the severity of the fire in general (as a measure of the foe we have to resist), I believe it was equal to Chicago, more severe than Boston, and what we might expect in the Wall St. or 23d St. districts of New York city, and nearly equal to what we might expect in the Dry Goods and East Side districts. I examined many buildings and much of the debris in all parts of the burnt district, besides inspecting some 1,700 windows and other features, and did not find enough melted iron, brick, stone, terra cotta and concrete to justify the claims of intense temperatures. I found the "melted granite columns" (so much written about) merely spalled and cracked by heat and water. The "melted solid cast-iron columns and steel beams" were merely buckled or distorted by heat or cracked and distorted by heat and water or falling material. It is some satisfaction to learn that a great conflagration does not melt the materials we can set up against it, and that scattered through the buildings are some samples of floors, partitions, beams, girder and column protection, skylights, etc., which were really severely tested and did resist the onslaught of the enemy.

To call these structures "absolutely fireproof" is a ghastly farce, to say the least, and especially so in view of all the data which has been collected from our daily experience of fires and from very extensive experiments. Similar ignorance as to the nature of the forces to be resisted, the peculiar quality of materials necessary, the design of details and the importance of supervision, would not be tolerated in important masonry, skeleton construction, building of dams, bridges, sanitation, etc. The practicable possibilities of fire protection if developed on the lines of true science and good art are that an interior fire can be limited to a small part of the floor in which it started, and an exterior fire need not damage the outside of the building more than 10 to 20% of the cost. This would be an enormous advance in the showing made in the best buildings of Baltimore, yet it is only an approximation to the success attained in other fields of labor.

But this end cannot be attained until the public demands it, and the owner appreciates that it is really to his advantage to require the architect to call in an expert who can advise him how to handle each case that is presented in a truly scientific and practical manner. I am satisfied that the cost of the Continental Trust Co.'s building would suffice to produce a building that would approximate very closely to the standard here suggested, and yet be a building fulfilling all the reasonable demands of convenience and architectural design.

But it would require a different distribution of the money, a reduction of some fireproofing and increase of others, a more practical choice of materials, adoption of better features from other buildings, attention to designing for fire exposure, a slight modification of some of the materials and shapes furnished by the contractors, and above all a careful supervision of construction from a fire-protection point of view.

Perhaps some day public policy may require more serious and efficient attention to solution of this problem. The fire disasters of Chicago, Boston, Baltimore, Rochester, the Iroquois Theater and the lesser fires of every day are almost as serious a menace to the general welfare as the dangers of disease, which have been so successfully reduced by the compulsory sanitation of cities.

Howard Constable.

22 E. 16th St., New York, Feb. 27, 1904.

Sir: Now that the excitement in the panic-stricken city of Baltimore has subsided, and spectacular newspaper accounts of the catastrophe have ceased, it is a proper time to consider the results of the fire analytically; also to draw from it definite conclusions which may serve as useful guides to future building operations.

Many statements have been made during the past two weeks in the public press regarding the existing conditions in the fire-swept area at Baltimore, which are misleading and not in accord with facts elicited by systematic, intelligent study of the ruins.

Insurance engineers, and experts from all parts of the country, have flocked to the stricken city to profit by this first opportunity of studying the effects of furious fire from without and within upon the modern so-called "fireproof buildings." The peril from a sweeping conflagration has been well understood by careful students of the fire hazard problem for some years. Much has been written regarding it, but the public has paid little heed. It is an unfortunate fact that it requires some fearful holocaust like the Iroquois Theater fire in Chicago or a conflagration like that of Baltimore to awaken people to a realization of the peril they are facing in a lack of proper fire precautions. It is to be hoped that advantage will be taken of this condition of the public mind to force a radical overhauling of the building regulations now in force in many of our cities, which permit the construction of veritable fire traps where nothing but the most fire-resistant building should be allowed.

It is a humiliating criticism upon our boasted claims of higher civilization that great fires like that in Baltimore are possible to-day just as they were a thousand years ago. Then they were attributed to Divine wrath, to-day we know they are the result of human neglect and ignorance. Having that knowledge, we should be ashamed that we have lacked the public spirit and interest in the subject necessary to make and enforce laws that would render such fires well-nigh impossible. This neglect of civic duties should be the first important lesson impressed upon the public mind by the Baltimore fire.

The gravity of the fire hazard in large cities has long been recognized by those who have made it a subject of study. Unfortunately, they had little encouragement, and with the exception of the work of a few pioneers, little was accomplished until about ten years ago, when the subject began to be investigated, both practically and scientifically.

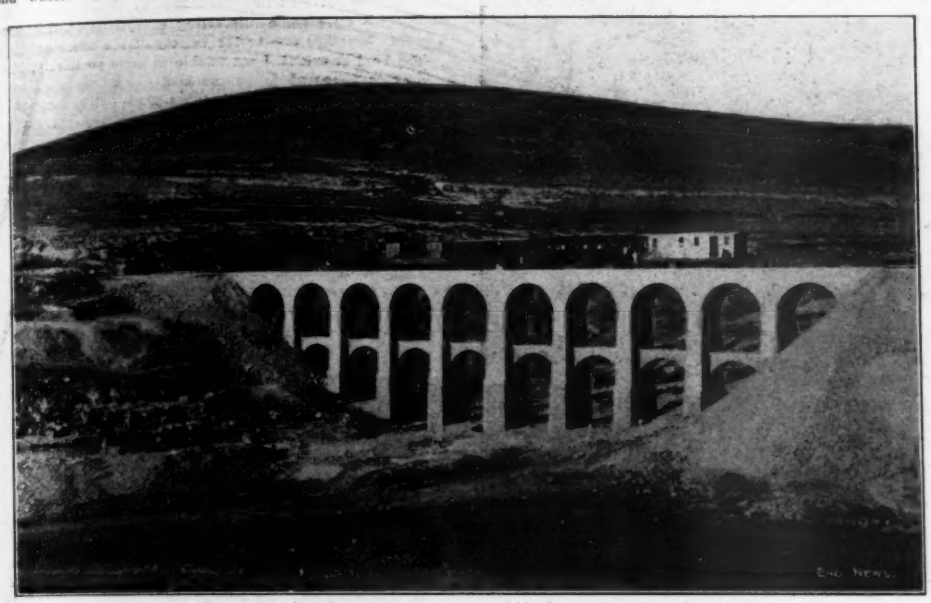
Fire prevention has now become a serious study among a large body of men in all parts of the world. A Fire Prevention Congress was held in London during July last, at which the writer had the honor of representing this city. The fact that 700 men, representing 15 separate world governments, assembled at one place, and spent a week discussing problems of fire prevention, is an evidence of the serious consideration the subject is at last receiving.

It is only within the past six or eight years that any special attention has been paid to the protection of the metal structure in a building. The only buildings really to be classed as fire resistant have been built since that time.

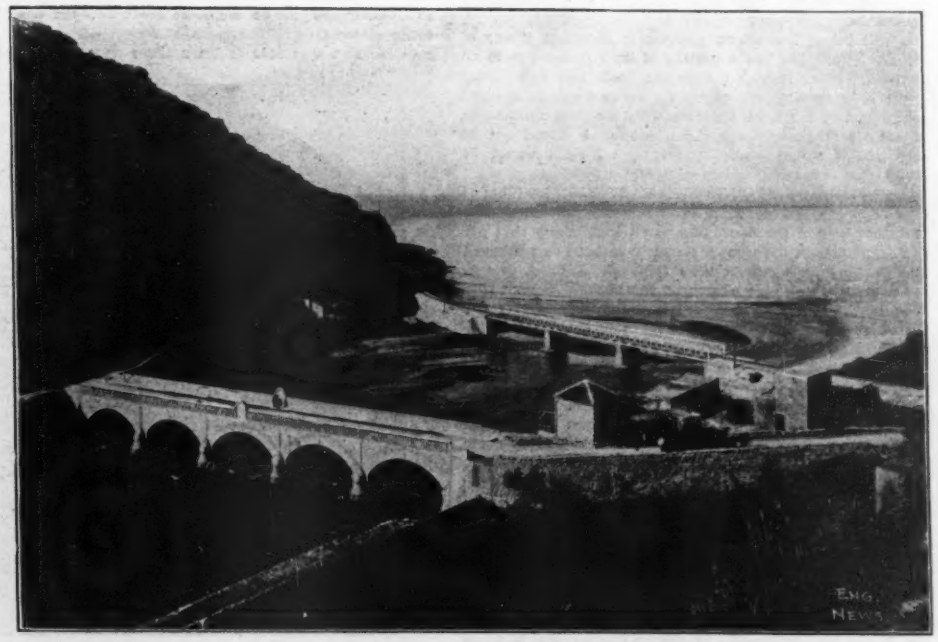
Numerous systems of fire-resistant construction have been urged upon builders during the past few years, and a large number of fire tests have been made upon these under the direction of the New York City Bureau of Buildings. I doubt if any city in the world has made so many and such severe tests as these have been, and to those of us who were familiar with the results it has been particularly gratifying to note that the effects of the Baltimore fire upon the modern fire-resistant building was just what we were lead to expect.

We knew that steel structural work when well protected would withstand a fierce fire for four hours, without injury, and we believed it would do it for a much longer period. The Baltimore fire proved this to be the case.

CONDITION OF STEEL AND IRON WORK.—In every instance where the beams and columns were thoroughly protected by an efficient non-conductive covering, they are to all appearances as good as when first installed. Where failure occurred it was due to either defective covering material or insufficient thickness. My own judgment is that 2 ins. should be a minimum thickness of covering material allowable, but 1 in. seemed to be the rule in the Baltimore buildings. It was surprising to see how well the I-beams stood the ordeal with so little protection to their bottom flanges.



VIADUCT ON THE DAMASCUS-MZERIB RAILWAY; HAURAN, SYRIA.



RAILWAY BRIDGE ACROSS MOUTH OF DOG RIVER, BEIRUT-DAMASCUS RAILWAY. ALSO MODERN BRIDGE WITH A MACADAMIZED ROAD.

How much of the steel work in the half dozen modern fire-resistant buildings in Baltimore will have to be replaced is still problematical. It is not yet certain that some of them will not have to be wholly razed. I should judge that at least 30% of the beams in the Equitable will have to be removed, together with a number of the columns, and yet it is quite possible that critical examination of the structures in other buildings may reveal conditions of weakness which will make it prudent to remove many beams which now appear safe. It is found that the upper floors of the high buildings suffered far more than the lower floors, due probably to the fact that the upper floors afforded the fire better ventilation than those further down. Owing to the risk involved in an investigation of these upper floors, they have not received as yet the careful inspection accorded those more easily accessible.

It will be an interesting problem to ascertain if any of the steel work has lost a portion of its stiffness due to an annealing effect resulting from the high heat and subsequent slow cooling caused by its encasement in the red hot protective material, together with the long application of hot air driven through the windows. I should not be surprised if many beams apparently all right would be found thus annealed and weakened.

CONDITION OF FLOORS AND PARTITIONS.—What is true regarding replacement of the metal construction is doubtless true of the floors and partitions. Many that are now in place and apparently sound have been so weakened that prudence will require their removal. A brick thrown against the under side of one of the arches on an upper floor of the Continental Trust Building last Friday revealed the fact that the tile were very brittle and insecure. How far this condition exists in all the buildings can only be determined by close scrutiny. Side construction seemed better than end construction.

Many of the partitions are also insecure. In general, partitions built of hollow tile or some form of partition block, appeared to be in better condition than those made of plaster on wire lath. A marked exception to this rule, however, was noted in the Equitable Building, where the partitions and much of the column protection were made of a composition cinder, plaster block, which failed badly, and will doubtless have to be wholly removed. In fairness to the material, it must also be stated that the same material was used for floor arches in several of the buildings and appeared to be in very good condition.

WINDOW PROTECTION.—The window protection of the Baltimore buildings was the weakest point in their fire-protecting armor. In very few instances was anything like adequate protection provided. Plain unprotected glass was the rule, and this offered no barrier at all to the assault of such a conflagration. Three or four buildings were glazed with wire glass, and as many more had either iron or metal-covered shutters, but they all failed where subjected to the direct attack of the flames. I learned of only one building—the Safe Deposit & Trust Co., on South St.—where a combination of wire glass and inside fire shutter was used, and this building escaped burning. Whether it was attacked as furiously as the others I cannot say, but it was surrounded by burned buildings, and it survived. It is reasonable to suppose that many other buildings on the outskirts of the fire would have been saved if similarly protected. It is quite possible that if all the large buildings had been so protected they might have escaped. Either the wire glass or the shutters would protect the building from an ordinary adjacent fire, but in a fire of this kind neither alone was sufficient. The glass failed by being set in defective sash, or by melting, and the shutters were warped and torn from their fastenings. Whether a fire shutter will be more effective inside or outside is a question worthy of investigation.

REINFORCED CONCRETE.—It is a matter of regret to all students of the fire-resisting problem that there was not one high building with reinforced concrete floors, so a better comparison might be made between it and the other systems.

So far as I was able to learn there were only three so-called fireproof buildings in which concrete floors were employed. These were the Fidelity & Guaranty Co., on German St.; the National Bank of Commerce, and the Commercial & Farmers' National Bank, both on South St. None of these were over four stories high, and in the latter only the two lower floors were reinforced concrete, the upper ones being wooden construction. The composition of the concrete in the Fidelity Building was 1 cement, 3 sand and 5 crushed granite. That of the Bank of Commerce was evidently a cinder concrete, but I have been unable to learn its composition, nor that of the Farmers' National. The buildings were all gutted, but the concrete floors were all apparently in first-class condition. The ironwork was not exposed and the concrete did not appear to be disintegrated. In the Commercial & Farmers' National Bank the wooden upper floors and roof burned out and fell together with a large safe down upon the second-story concrete floor, and it did not fall. This is evidence of very efficient construction.

EFFECTS UPON STONE.—As already pointed out in your last issue, all varieties of natural stone suffered severely from the fire. Granite, sandstone, limestone, marble and slate all perished before the long-continued high temperature. Granite and sandstone cracked and spalled, limestone and marble cracked and calcined, while the slate shivered into thousands of thin plates.

There were some interesting exceptions to this general rule. Whether due to the variety of the stone or the way the heat struck it, I am unable to state positively, but the former appeared to be the controlling cause. A careful study of all the various stones used in the burned area, at the same time ascertaining the quarries from which they came, would be a valuable contribution to the other lessons of the fire.

Maryland granite, such as used in Maryland Trust Building and the Custom House, failed badly. The same was true of the granite in the B. & O. Building, which was said to come from Missouri. On the other hand, the Milford granite in the Equitable was little damaged, and that in the Calvert Building (which looks like a New England stone) is in fair condition. The most remarkable preservation of granite I noticed was the polished granite front of the First National Bank on South St., facing German. It is in perfect condition, despite the fact that nothing but the walls remain. The variety of stone I was unable to learn.

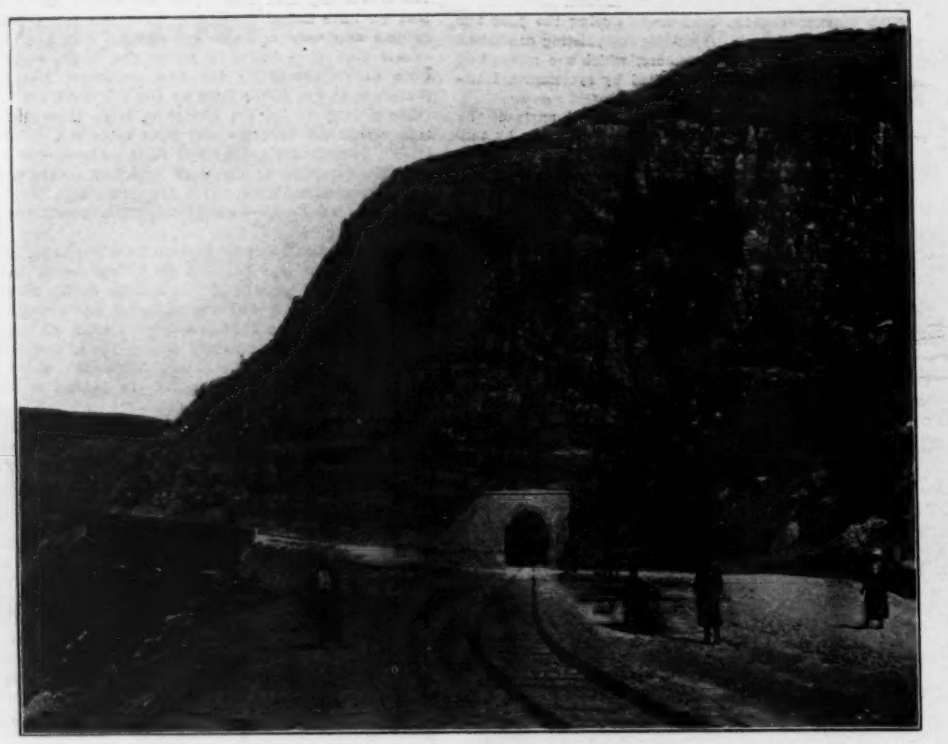
Sandstone should give the best record of any of the stones, but in most cases it seemed to have succumbed like the others. Lake Superior red sandstone appeared to be the stone employed in the Farmers & Merchants' National Bank, corner South and Lombard Sts. It was badly spalled.

Brown sandstone gave an equally poor showing in numerous buildings, but I noticed the front of three buildings which were in remarkable contrast, for they were uninjured. One was a small building on south side of Baltimore St., just east of the Continental Trust Building, another was the Savings Bank of Baltimore on Gay St., opposite the new Custom House, and the third was a building a few doors north of the Savings Bank on the same street. Both these buildings had wooden interior construction and were completely burned out, as well as all the surrounding buildings, but the face walls withstood the heat without apparent damage, while the huge granite blocks of the Custom House a few doors away were ruined.

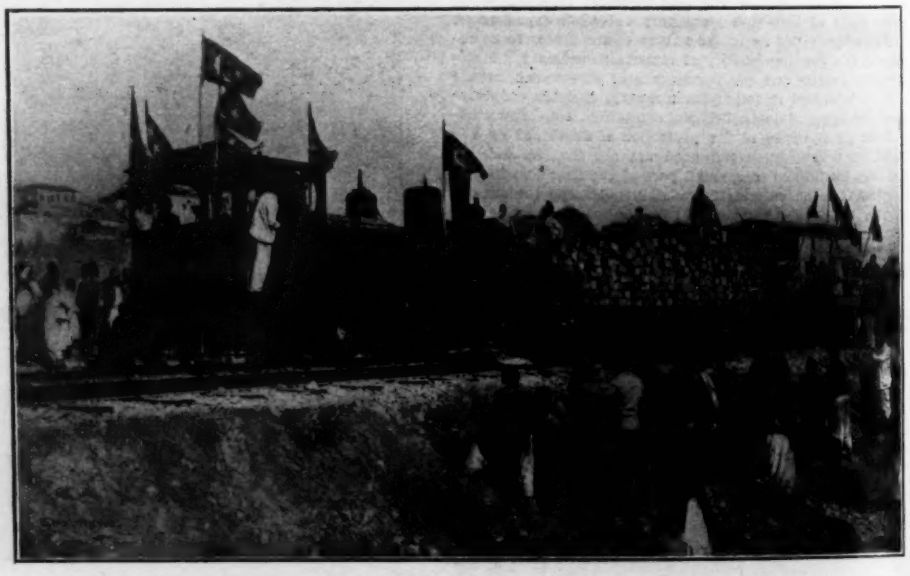
I was unable to learn the source of this stone, but it certainly had good fire-resisting qualities.

A WORD REGARDING THE DEGREE OF HEAT PRODUCED BY THE FIRE.—My judgment is that the heat of this fire has been greatly overestimated. Very few people have any accurate idea of the difference between one, two or three thousand degrees Fahrenheit, consequently they give extravagant estimates, which are unsupported by facts. Because a fire is large in volume it is not necessarily any hotter than a smaller blaze.

The temperature of the Baltimore fire has been variously



PORTAL OF THE SOFAR TUNNEL, IN THE LEBANON MOUNTAINS, BEIRUT-DAMASCUS RAILWAY.



CONSTRUCTION TRAIN ON THE HAIFA-MZERIB RAILWAY; DECORATED IN HONOR OF AN OFFICIAL INSPECTION.

estimated by numerous writers as 2,500° to 4,000° F., and the statement has been repeatedly made that different kinds of metals were fused, including cast iron and steel. Now I will not dispute that such things may have occurred in rare instances, but as a general proposition the statements are not founded on fact. In going through the ruins myself I looked carefully for evidences of melted metal, and I have asked a number of other gentlemen who have studied the ruins carefully, and thus far I have been unable to find a single instance of the actual fusing of metals other than solder and lead.

Glass melted freely, and hung down from the light fixtures in fantastic forms, but the brass fixtures were everywhere intact so far as I have been able to learn, and the same was true (except for the soldered parts) of thermometers, clocks, telegraph call boxes, typewriting machines, as well as brass, bronze and iron railings, which were plentiful in all the buildings. Iron was sometimes distorted, but if under stress it will do that easily at a red heat or about 800° F. From all this evidence I am convinced that the average heat of those buildings was not far from 1,500° to 1,800°. Glass softens and flows at 1,000°, and melts at 1,200° to 1,800° F. Brass will go from 1,800° to 1,900°, while cast iron requires 2,000° or over, and wrought iron 2,700° to 2,900°.

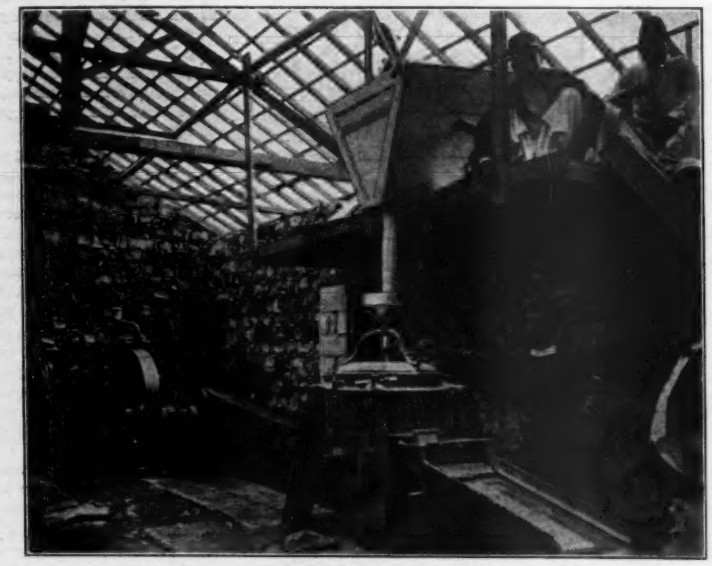
The reason for such complete combustion of all inflammable material was because of such long continued heat, and the fact that after a building had burned out, the air that blew through it was heated to a furnace temperature by crossing acres of fire. So it completed the destruction of any particles of wood or other material which had previously survived.

This question of temperature is a valuable one to those of us who conduct practical fire tests upon building materials. The Building Code of this city has adopted 1,700° F. as the temperature at which its tests are to be made, assuming it to be the average temperature of a burning building. It has been somewhat criticised in the past, but I think the results at Baltimore prove that 1,700° is as nearly correct as it can be made.

In conclusion I would state that the lessons of the Baltimore fire firmly convince me that the modern steel cage building can be made entirely fire resisting (not fireproof). That even when attacked by such a conflagration as that at Baltimore they may burn out, but will remain structurally intact, and in lesser fires whether from within or without they would not be wholly consumed.

Yours very truly, Ira H. Woolson.

New York City, Feb. 23, 1904.



DRIVING A FLOUR-MILL WITH AN AMERICAN OIL-MOTOR.

A PROPOSED HIGH PRESSURE WATER SUPPLY SYSTEM FOR FIRE PROTECTION IN CHICAGO.

The project for a high-pressure water supply system in Chicago for the fire protection of the business district, was described in our issue of Sept. 25, 1902, and July 9, 1903. We now present an abstract of a report made to the commission appointed to consider this matter by Mr. Geo. W. Jackson, M. West. Soc. Engrs. This report presents a plan for the protection of the district bounded by Michigan Ave., 12th St., Halsted St. and Chicago Ave. The main conduit is to be a tunnel beneath the bed of the Chicago river, with lateral tunnels at certain points to shafts where connection is made with the distribution system. An abstract of the report follows:

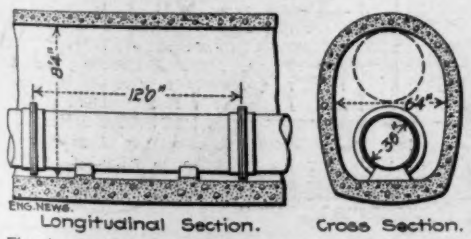


Fig. 1. Main Conduit for Proposed High-Pressure Fire Protection System for Chicago.

The system is designed for a capacity of 30,000 gallons per minute, equal to 43,000,000 gallons for 24 hours, with a pressure at the pumps of 300 lbs. per sq. in., the trunk mains and lateral conductors being of sufficient size to give a hydrant pressure of 200 lbs. per sq. in. after being forced through a trunk main 36 ins. diameter, 9,000 ft. in length, with a velocity of 9 ft. per second, and 8-in. conductors a distance of 4,000 ft., which would be the maximum distance the water would be subject to friction in order to reach any point in what is known as the down-town district. In order to get this efficiency a conduit 6 ft. 4 ins. × 8 ft. 4 ins. is designed, to be constructed by the tunnel method, and to be placed at about the center of the Chicago River at an average depth of 70 ft. below datum. From this conduit, Fig. 1., lateral distributors 4 ft. in diameter are designed, to be built to a point about 100 ft. inside of the dock line and on such streets as are selected. A 4-ft. vertical shaft is to be sunk from street grade to connect with the 4-ft. lateral.

In the tunnel conduit there is to be a 36-in. steel pipe, with proper flange connections, to stand a hydrostatic pressure of 1,800 lbs. per sq. in. A 12-in. steel pipe is placed in each lateral and shaft, to a point about 8 ft. from street grade. To the 12-in lateral two 8-in. cast-iron conductors are connected, made to stand a hydrostatic pressure of 800 lbs. per sq. in., and to be laid in the streets, with the necessary valves and fire hydrants. Fig. 2 shows the cast-iron and steel pipe, as recommended.

The location of the power house is left for the Commission to decide, it being practicable to locate it anywhere along the line of the present water supply found under the city. The power plant would require about 24,000 sq. ft. of land. The most economical and practical power for pumping purposes is that which is generated by gas, from the fact that it will not become necessary to keep up pressure at all times. There is no question as to the absolute, positive operation of gas engines, and the cost of installing gas engines as compared with boilers and engines is about the same. The cost of maintenance per year would be about $8,000 less, if power is generated by gas engines, as compared with the generation of power by steam.

As to obtaining the necessary water, it will be practicable to use the surplus water from the present 7-ft. tunnel which furnishes the supply to what is known as the Harrison St. pumping station. This tunnel has a capacity of 72,000,000 gallons per 24 hours. The pumping station has a pumping capacity of 33,000,000 gallons per 24 hours, and as the high pressure system is designed for 43,000,000 gallons per 24 hours it would not impair the water supply at that station. I do not believe it will become necessary for the fire department to use for over an hour a supply of water equal to 43,000,000 gallons per 24 hours; and in the construction of a high pressure plant provisions should be made to construct at some future day a tunnel for a supply independent of the domestic water supply. It would be unwise to permanently design a power house with the idea of using the river water, on account of the sediment it contains, experience having taught me that the uncertainty of the operation of valves and hydrants becomes a very important feature, especially so when valves and hydrants are subject to high pressures from water containing sediment.

The reason for placing the high pressure trunk main in the center of the river was due to the impracticability of placing any large mains in the streets of the down-town district, and even with the installation of 8-in. mains a large element of danger from damage would always be probable if it ever becomes necessary to have 8-in. high pressure mains installed in any subway which might be built for the transportation of people.

As a preventive to the spreading of fire after its start, sprinkler systems should be installed in all buildings as a precaution and aid in extinguishing fire. A system of tanks should be located in the basement of buildings or below the basement floor, these tanks to be of a size to hold a supply of water sufficient to supply the sprinkler system pending the arrival of the fire department. The tanks should be connected to a small air compressor, the compressor to be installed with an automatic starting device in such a practical manner that if the sprinkler system becomes operative, the automatic device would start the air compressor in order that the compressor would generate compressed air of sufficient pressure to force the water in the tanks through the sprinkler system to the required height necessary, or the tanks can be connected to a high pressure pump automatically started in buildings, but provisions should be made to prevent the sprinkler system from freezing.

This system does not require the attention of an employee or engineer during the hours of the day, and especially so at night, when power is not kept up in the different buildings or manufacturing plants, when they are not operating actively, as the compressor can be connected to an electric motor and the current necessary to operate the starting device can be acquired from electric power generated and sold by corporations engaged in selling electric power. With a tank and compressor system installed in this manner, it obviates the necessity of reconstructing buildings or the erection of supports heavy enough to properly carry a tank of water on the roof of buildings of such size to hold a quantity of water necessary to have the assurance of sufficient flow. It also overcomes the objection from a financial standpoint, as the installation of a tank system with air compressor or high pressure pump can be installed in latter-day constructed buildings at a nominal cost, in addition to not occupying any room now occupied or which might be occupied in different buildings, as the tanks can be installed below floor level.

I do not believe the city could afford to assume the responsibility of connecting the high pressure mains to the sprinkler systems without an intercepting valve, on account of the amount of damage that might occur from the uncertainty of pressure from the high pressure mains due to water rams, this uncertainty being such that it has been almost impossible for engineers to positively calculate the pressure that might come from the mains due to their becoming air bound. If air accumulates in the pipe systems and gets to a point between automatic air valves, it is at times the cause of serious water rams, and the pressure caused by these water rams varies to such a degree that it becomes necessary to have the mains and different conductors tested to such a pressure that I am unable at this time to feel satisfied that any appliance designed to work on sprinkler systems, would give the degree of safety necessary to withstand this added pressure, and at the same time have the assurance that the sprinkler systems would act at the time they would be expected to operate; or if a serious fire should occur in a number of buildings, such as has recently occurred in Baltimore, if sprinkler systems installed in buildings were connected to the high pressure system direct, it would be the means

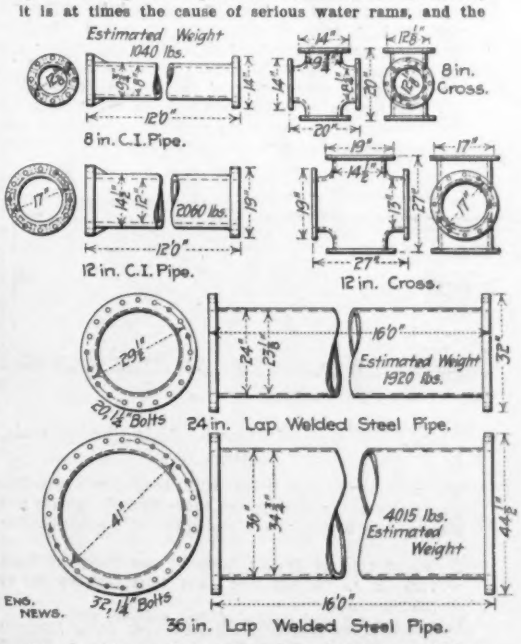


Fig. 2. Steel and Cast-Iron Pipe for Proposed High-Pressure Fire Protection System in Chicago.

of seriously crippling the high pressure system, caused by water discharging from the high pressure mains at a time when it would be of no service in putting out fires, to say nothing of flooding the different premises.

I therefore recommend connecting the sprinkler systems to the high pressure water mains, with a shut-off valve placed outside of the curb wall; this valve to be controlled by the fire department.

VALVES AND HYDRANTS.

The system of valves and hydrants has a sufficient number of shut-off valves to practically control the system in any block without shutting off any large territory, the hydrants being placed at street intersections and in the center of blocks, allowing the fire department to have sufficient hose connections to hydrant, making it unnecessary to have lengths of hose exceeding 200 ft. in order to reach standpipes or dry sprinkler systems.

A telephone system should be installed in connection with the high pressure mains, and the system should be built for the use of the Chief of the Fire Department and his assistants. An independent switch board should be installed at the power house of sufficient phone capacity, and the necessary wiring installed, in order that the Fire Marshal or his assistants would have telephone connection to power house, on one corner at each street intersection. A portable tripod with telephone connection should accompany this system, these portable tripods and phones to be a part of the equipment of the fire department.

Estimated Cost of System Covering the Territory from 12th St. to Chicago Ave., and from Halsted St. to Michigan Ave.

11 gas engines and pumps (2,800 gallons per minute each), 600 HP., at $52,000 each	$572,000
Property, 24,000 sq. ft., at $9	216,000
Power and pump building complete	110,000
Trunk main conduit, 11,300 ft., at $25 per lin. ft.	282,500
Lateral conduit 4 ft. in diameter, 6,900 ft., at $11 per lin. ft.	75,900
36-in. pipe, 8,600 ft., at $16 per lin. ft.	137,600
24-in. pipe, 2,800 ft., at $12 per lin. ft.	33,600
12-in. pipe, 61,200 ft., at $5.60 per lin. ft., including specials	342,720
8-in pipe, 237,200 ft., at $4.75 per lin. ft., including specials	1,126,700
850 fire hydrants, at $120 each	102,000
36-in. valves (4) at $800	3,200
24-in. valves (3) at $500	1,500
12-in. valves (72) at $130	9,360
8-in. valves (880) at $80	70,400
Telephone system complete (200 phones)	120,000
Total	$3,203,480

Estimate of Cost for the Business District, with Pressure Acquired from Fire Boats.

12-in. pipe, 5,000 ft., at $6.40 per lin. ft., including specials	$32,000
8-in. pipe, 125,200 ft., at $5.10 per lin. ft., including specials	638,520
335 fire hydrants at $120	40,200
12-in. valves (10), at $130	1,300
8-in. valves (574), at $80	45,920
10 fireboat connections complete, at $900, installed	9,000
Necessary wiring and conduit for telephone system	25,000
Total	$791,940

With this system and with a power house designed and installed with a pumping capacity of 43,000,000 gallons per day of 24 hours, with an indicated cold water pressure of 300 lbs. per sq. in. at the discharge end of the pumps, a flow of water equal to 22,000 gallons per minute can be discharged from a system of 16 hydrants. With this pressure and discharge of water the fire department would have available 44 1½-in. streams, and would be able to have a flow of water from each stream equal to 220 gallons per minute through a 1¼-in. nozzle after being conducted through 150 ft. of 3-in. hose and 300 ft. of 3-in. vertical standpipe, with a nozzle pressure at an elevation of 300 ft. above street level of 25 lbs. per sq. in., which would throw water 40 ft. horizontal and 35 ft. vertical, or would give a height of water of 335 ft. above street level.

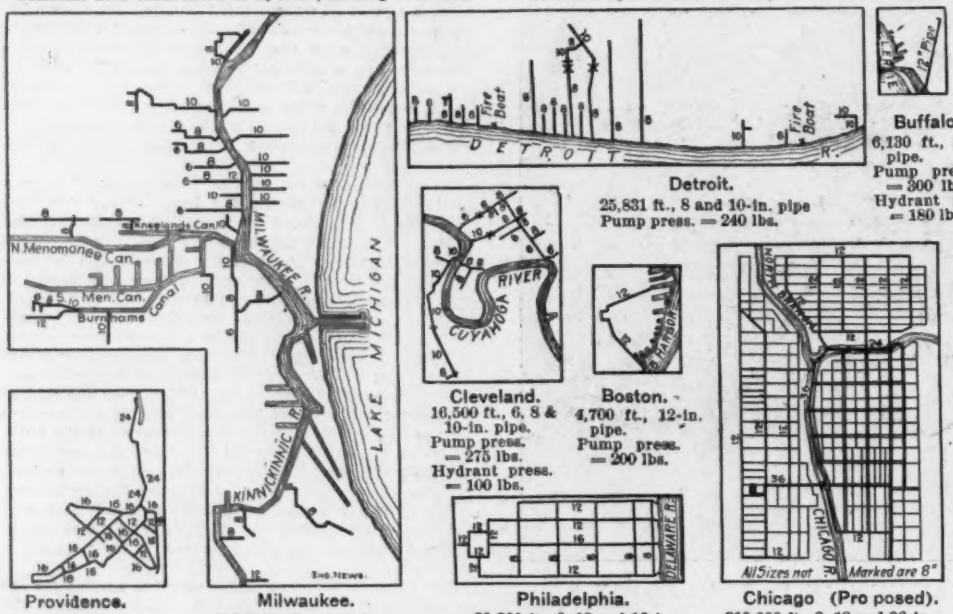


FIG. 3. MAPS OF HIGH-PRESSURE WATER SUPPLY SYSTEMS FOR FIRE PROTECTION IN DIFFERENT CITIES.

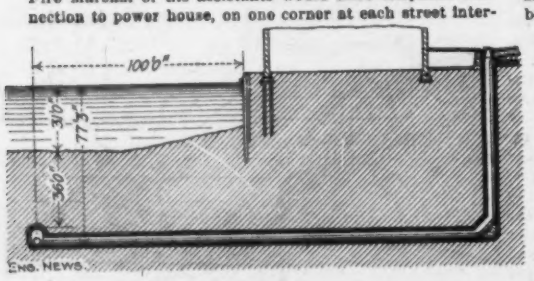


Fig. 5. Section of Proposed Main Conduit and Lateral.

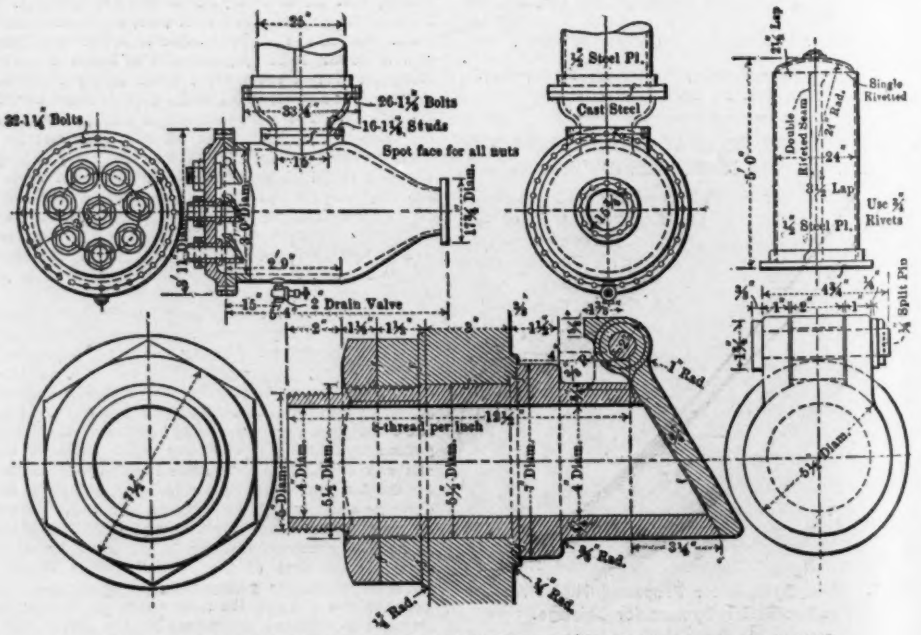


FIG. 4. DETAILS OF FIRE BOAT CONNECTION TO HIGH-PRESSURE MAINS.

The proposed work will not interfere with the construction of a subway, or if such a subway is to be built, the system can be kept in operation with the exception of a possible discontinued service from the high pressure mains to the extent of one block, during the construction of subway, and at the same time obviate as far as possible, any element of damage to property owners or individuals, as well as removing the danger of flooding a traction subway due to possible break.

Appreciating the importance of a high pressure system to Chicago, especially in the down-town district, and having in mind the condition of the city finances, I have endeavored to make it possible to start installation of the system with the money now available. Any part of the system in the down-town district can be installed, and as the fire department has a suitable fireboat (which has a capacity of about 8,000 gallons per minute, an adequate supply of water for one fire), the system could be supplied from the fireboat pending its final completion.

I have also had in view the recommendation of a plan which would take care of the unsanitary condition of our present sewer system, feeling satisfied that the high pressure system should be connected with our sewer system for the purpose of flushing subsoil sewers, as well as for the washing of our streets; but after thoroughly canvassing the situation I found it impracticable at this time, or at least unwise, to plan a new sewer system until such time as the subway question would be settled. The reason for this is, that knowing from absolute experience the condition of our streets and alleys (having constructed most of the underground systems for the different corporations operating under franchises granted them by the City Council), these, as well as our present sewer, fire-alarm, electric lighting and domestic water pipe systems, occupy the street intersections to such an extent, that a new sewer system should not be built until something definite is arrived at relative to subway.

There has been some discussion as to the practicability of deriving a revenue from the sale of power by the city. In this connection I would like to add that the city's present domestic water supply can be materially increased by using the space allotted in the 6-ft. 4-in. x 8-ft. 4-in. conduit if it becomes desirable to do so, as a 36-in. steel conduit could be installed in the conduit and connected to the domestic water supply and used as such, pending the time necessary to use the said 36-in. main for fire purposes, as it may become necessary from time to time to extend the high pressure system.

Fig. 3 shows skeleton plans of the existing high pressure mains as adopted in Buffalo, Cleveland, Detroit, Milwaukee, Providence and Philadelphia, and the Chicago system as outlined. In the cities as mentioned and as shown on plate comparing the systems as to area covered, the Chicago system covers about three times the area of any of the other cities. The only city which has as yet installed a power plant is Philadelphia, the power for this city being generated by gas engines, the rest of the cities obtaining their pressure from fireboats or reservoirs.

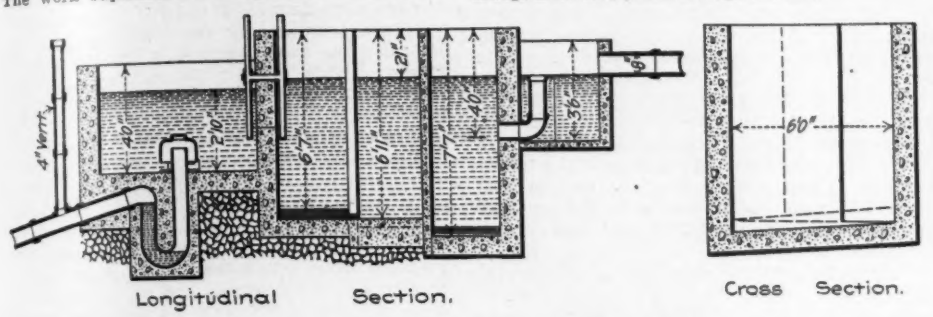
I have come to the conclusion that it would be impracticable, for the power as now generated by manufacturers and managers of the different buildings can be produced

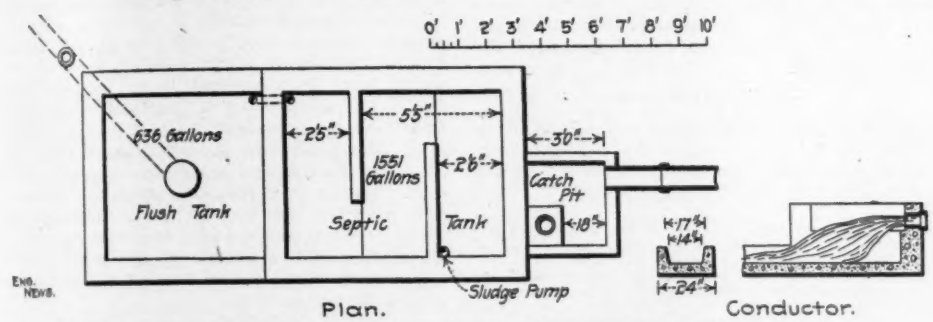
as economically as it could be if generated by high pressure pumps. On account of the uncertainty of water consumption, if the high pressure mains were used for generating power, it might seriously interfere with the necessary flow and pressure required for fire purposes.

The high pressure system should be constructed for fire purposes only, and its operation should be under the absolute control of the Chief of the Fire Department, in order that there may be no friction or misunderstanding of orders by subordinates at the power house.

SEPTIC TANK AND BROAD IRRIGATION FOR SEWAGE DISPOSAL AT THE PROVINCIAL JAIL, VICTORIA, B. C.

A small plant designed to treat from 1,200 to 1,800 gallons of sewage a day was placed in operation on Dec. 20, 1901, at the Provincial Jail, Victoria, B. C. Mr. E. Mohun, M. Can. Soc. C. E., was engineer for the plant and recently submitted a description of it to the Canadian Society of Civil Engineers. The work superseded a dilapidated main sewer and untrapped overflowing brick cesspool, all of which had become a nuisance.





CATCH PIT, SEPTIC TANK AND AUTOMATIC FLUSH TANK, PROVINCIAL JAIL, VICTORIA, B. C.

(The pit and tanks are covered with plank.)

The catch pit, septic tank and automatic flush tank, shown by the accompanying illustrations, are located about 250 ft. from the buildings. The tank discharges about twice a day onto a nearby irrigation area, laid out in alternate ridges and depressions, with distributing channels on the ridges.

The chief object of the catch pit is to intercept foreign matter maliciously thrown down the water closets by the prisoners. The matter it retains is removed from time to time and buried. The pit discharges into the septic tanks at a point 2.25 ft. below the water level in the pit and tank, through a 6-in. trapped pipe.

The baffle walls in the septic tank were designed to make the tank serve the same purpose as one of greater length and cost. The outlet from the septic tank is from 2-in. wrought iron pipe, H-shaped, with an entering limb 2.25 ft. below the horizontal discharge, designed to prevent siphonage and to facilitate cleaning.

A 6-in. Miller siphon is in use, discharging into an aerating trough of No. 26 galvanized iron, with slits in the bottom and end, set 15 ins. above a level concrete trough which leads to eleven distributing channels extending over the irrigation area.

The land upon which the sewage is turned is "a stiff clay, fit for brickmaking, with practically no loam on the surface." About a quarter of an acre of land "was thoroughly dug, and the sewage has generally been applied to this area, though occasionally diverted to an adjacent piece under cultivation." The irrigated area appears to have been "much improved" by the septic tank effluent, and "sweet corn, peas, cabbages, beets, carrots and leeks have been raised of excellent quality."

No analyses of sewage or effluent have been made. As stated, the plant was put in operation on Dec. 21, 1901. To quote from Mr. Mohun's paper:

The surface scum in the septic tank was of very slow growth; indeed the tank was working fully six months before a complete coating was formed. During that period the effluent was very turbid and somewhat offensive. Since then there has been a marked improvement. Though not absolutely clear, it is inoffensive, except when confined for some hours in the conductor.

The surface in the septic tank in May, 1903, was completely covered with a coating about 2 ft. thick, from which no offensive odors arise.

On May 18, 1903, a sludge pump was placed in position in case there should prove to be a considerable amount of sludge deposited during the 18 months' work of the tank. In that period from 650,000 to 800,000 gallons of sewage must have passed through the tank.

The pump has a 2½-in. suction, reaching to 8½ ins. above the bottom of the tank. On starting it, no sludge deposit was found at that depth, the discharge being precisely similar to that of the catch pit.

The pump was placed in position so that, in the event of the tank area available for liquid sewage becoming restricted, it would always be possible to remove a few yards of sludge without disturbing the surface scum, and with the least possible trouble and annoyance.

THE CAR FERRY BRIDGE OVER THE SHIP CANAL at Duluth, Minn., is to be built by the Modern Steel Structural Co., of Waukesha, Wis., which has just been awarded a contract for the work by the city of Duluth. The bridge was designed by Mr. C. A. P. Turner, M. Am. Soc. C. E., of Minneapolis, and was fully illustrated in Engineering News of March 20, 1902.

The span is to be erected as a cantilever so as not to obstruct the channel during erection, the plan to erect it during the season when navigation is closed having been abandoned.

A HIGH-HEAD WATER POWER PLANT is soon to be constructed near Everett, Wash. The water of Lake Isabel, a mountain lake, will be carried by pipe-line to a point two miles distant, with a drop of 2,500 ft. A power house at this point is to develop 10,000 HP. by impulse wheels. The energy generated is to be carried to Everett by an electric transmission line, to supply power for street railways and lighting. The highest head of water now utilized in this country is 1,960 ft., at Redlands, Cal.

A CENTENNIAL ANNIVERSARY of the locomotive engine is called to public attention by the English journal "Transport," which records that on Feb. 13, 1804, Richard Trevithick tested an engine upon tram-plates on a private tram-road running from the Penydaran Iron Works, near Merthyr Tydvil, down to the canal basin at Quaker's Yard, in Glamorganshire. The engine was more like the steam roller or traction engine of the present day than the railway locomotive, inasmuch as it had a single horizontal cylinder, a fly-wheel, and was driven by spur gearing instead of direct action.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision between freight trains on the Chicago Great Western Ry. near Dyersville, Ia. Six or seven persons were killed. The accident seems to be chargeable to a fault in the train dispatching.

AN EXPLOSION OF DYNAMITE on the Southern Pacific R. R., Feb. 15, killed 24 men and seriously injured 12. Two freight trains collided at Jackson, on the Ogden-Lucin cut-off, 85 miles west of Ogden. A car load of dynamite was exploded by the collision, wrecking every structure within half a mile. The report was heard in Ogden, 85 miles away.

AN INSPECTOR OF TRAIN SERVICE has been appointed on the Southern Pacific, with the following duties:

1. Condition of passenger train equipment and the general appearance of trains; cleanliness and freshness of coaches both inside and out; ventilation; conditions of toilets, drinking water; lighting and heating apparatus; windows; plush and seat fixtures, etc.
2. Condition of equipment and character of service in sleeping and dining cars.
3. Condition of waiting and baggage rooms and toilets, and treatment of the traveling public at stations.
4. Respect paid to flagging rules and signals; condition of train and locomotive markers, switch lights and targets, fixed station and block signals.
5. Failure to maintain schedules and reasons therefor; excessive speed, etc.
6. The relation of train and station employees to the public; condition of uniforms, badges; attention to duty, etc.
7. In general, any other matters connected with train and station service not up to requirements.

ELECTRIC LIGHTING is to be adopted for all passenger trains on the Chicago & Alton Ry. The system will be one in which a dynamo is driven from the car axle.

TYPHOID FEVER OUTBREAKS of more or less seriousness are reported every few days. Aside from those already noted in this and preceding issues of this journal, the following may be outlined:

Sharon, Pa.—A relatively large number of cases were reported here in January, but the present status is unknown.

Cohoes, N. Y.—An unusual amount of typhoid fever for some weeks past has been reported and water filters are proposed.

Rochester, Pa.—On Feb. 15 it was stated that 50 cases, attributed to pollution of the Beaver River by the sewage of typhoid-stricken Butler, has been reported.

Montreal, P. Q.—It is understood that a report on the recent outbreak in Montreal and its suburbs will soon be made by Dr. Beaudry, Provincial Health Officer. The Montreal Water & Power Co., which supplies part of the territory afflicted with typhoid, has instructed its engineer to prepare plans for filters.

Fort Wayne, Ind.—Meager and somewhat contradictory reports lay some 75 cases to the alleged admission of foul water to the city water mains from the supply pipe of one of the railways, the two pipes being connected for emergency use. The incident, if true as reported, is similar to the occurrence at Lowell, Mass., last year, described in our issue of Feb. 11, 1904.

Franklin, N. H.—A sufficient number of cases having occurred to attract unusual attention, an investigation was made, including some water analyses. It was concluded that an emergency supply, from a pulp mill pond, was probably responsible for the outbreak, the water giving evidence of contamination. Notices to boil the water before drinking it were served.

Cleveland, O.—During the month of February there were 465 cases of typhoid fever and 45 deaths. On March 1 there were 68 new cases reported. The infection is attributed largely to the pollution of the lake by the inflow of surface washings during or after a thaw. The new water-works tunnel was recently put in use, but not long enough ago, it is said, to have effected any change in the typhoid situation. The construction of a filter plant for the entire supply is under discussion.

A SUIT FOR FAILURE TO FURNISH FIRE PROTECTION was recently brought against the East Jersey Coast Water Co., of West Asbury Park, N. J., by the Buchanan & Smock Lumber Co., of Asbury Park, N. J. The plaintiffs had hired of the water company two fire plugs for fire protection only. At the time the fire broke out in the lumber company's plant there was no water of any amount to be obtained from these plugs. The consequent delay in the firemen having to abandon these hydrants and go further away, was made the basis of the suit, the company having plenty of water in its system. The failure of the water in the fire plugs in question was caused, as nearly as can be ascertained, by the closing of a valve in the main supplying these fire plugs. The jury gave a verdict against the water company.

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In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 325 means that subscription is paid to the 32d week (that is the issue of Aug. 10) of the year 1905; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see pages 26-27. New copy for standing advertisements should be received ten days in advance of publication; new advertisements, Monday morning. The pages containing "Want" advertisements are held open until Tuesday, and those with "Proposal" and "For Sale" advertisements until Wednesday at 11 a. m.

The Brooklyn Bridge terminal question is again brought to public notice through the presentation by Bridge Commissioner Best of a proposed plan of improvement involving an expenditure of several million dollars. That this expenditure will be authorized at a time when demands on the city for heavy outlays in other directions are so numerous and pressing, seems exceedingly improbable.

If the city authorities really desire to improve the Brooklyn Bridge terminal facilities, we commend to their careful consideration the plan of Mr. S. S. Neff, which we publish in this issue. Mr. Neff is an expert engineer particularly well fitted by his past experience on the Chicago Elevated loop and the Boston Elevated Ry. to deal with problems of this character. He has not merely given to this problem a few spare hours from other affairs, but has made it a special study in connection with work as consulting expert to the Brooklyn Rapid Transit Ry.

His plan for the Bridge terminals, elsewhere presented, certainly commends itself for its common sense treatment of the situation. He proposes no tedious and expensive real estate condemnation, but works out a plan which can be carried out without the purchase of a foot of land and even without radical alteration of the present terminal building. Its total cost, therefore, will be a mere fraction of that involved in the plans hitherto presented.

The strong point of Mr. Neff's plan is the movement of the Brooklyn Elevated trains across the bridge so that passengers can go to and from points in Brooklyn to the Manhattan terminal of the bridge without change of cars and for a single fare. This is greatly to be desired from every point of view, and if it can be accomplished, it would, we believe, effect a thoroughly satisfactory solution of the Bridge terminal problem, which has been before the public in one shape or another now for nearly 20 years.

For the readers who may not take the time to study Mr. Neff's plans in detail, we may say that what he proposes is to furnish five platforms, for receiving and discharging passengers at the Manhattan terminal, with nearly 20,000 sq. ft. of area, in place of the less than 5,000 sq. ft. available under the present system. These platforms will accommodate six-car trains in place of the present four-car trains, thus emphasizing the principle that the traffic capacity of a railway system is governed by the length of trains, so ably set forth by the late A. M. Wellington in his papers on the Brooklyn Bridge terminal problem.

In addition to this, a most important feature of Mr. Neff's plan is the rearrangement of the car yards at the Brooklyn end of the bridge to give storage for relay trains. From a practical operating standpoint, this is an absolute necessity, if the bridge tracks are to be operated to their full capacity during rush hours, as they must be if satisfactory service is to be given and through trains are to be run over the bridge. It is a practical impossibility to operate any railway line several miles in extent and keep all the trains moving with absolute uniformity; yet a gap of only two or three minutes between trains moving across the bridge means the accumulation of crowds on the platforms. To successfully operate through trains over the bridge, therefore, the official in charge must have relay trains at the bridge, ready to put into service instantly when delays occur in the arrival of trains already in service.

Finally, while Mr. Neff's plan relates only to the operation of trains over the cable railway tracks, it has a very close connection with the crush around the surface cars at the loops of the trolley terminal. These surface cars are now densely crowded in rush hours because passengers can take them and go through to their destination for a single fare.

If the same condition obtained on the elevated railway trains, as would be the case under Mr. Neff's plans, a large proportion of these passengers would take the elevated trains in preference, thus largely relieving the crowding around the trolley terminal.

An old question as to the use and misuse of the letters "C. E." after one's name is raised by a correspondent who asks us to reply to the following questions "to settle a discussion:"

(1) Is it proper for any one, no matter what his experience, to write the two letters "C. E." after his name unless the Degree of Civil Engineer has been conferred upon him by some institution of learning?
(2) Is it improper for one, who has had years of experience in municipal engineering and land surveying, to advertise as "Civil Engineer and Surveyor," and if so, what should such an one call himself or how should he advertise?

Whichever way our correspondent's first question is answered, there will doubtless be plenty of people to disagree with the answer, for the matter is one on which opinions are bound to differ. Our opinion is that so many men of limited education and experience have written "C. E." after their names that it is at least open to question whether an engineer of real ability and standing gains anything by doing it. As to there being an impropriety in a man's assuming the title unless he has been granted it by some institution of learning, we should say that it depends on the man. There are many engineers whose professional standing and qualifications are superior to those of the average engineering school graduate. If such a man derives any satisfaction from writing C. E. after his name, we see no impropriety in his doing it.

As to the second question, the man who is carrying on business as a "civil engineer and surveyor" has a perfect right to state that fact on his "shingle" and on his professional card. Such a sign carries no shadow of a claim to the possession of an academic degree and would never be so construed by the general public. One ground on which objection is made to writing the letters "C. E." after one's name is that the one who does so may be understood to be laying claim to an academic honor which he never received. This objection cannot apply at all to the use of the term "civil engineer and surveyor."

Several typhoid epidemics have been traced to the entry of polluted water to the leaky joints of a submerged suction main; but the instance at Leadville, Colo., reported in this issue, is the first on record, so far as we recall, where polluted water entering a main of the street distribution system has caused an epidemic. The polluted water entered, it is supposed, when a main was emptied for repair, gaining access through leaks in the pipe. We say the case is the first on record; but it is altogether likely that in not a few instances disease germs have thus been introduced into public water supplies, and the source of the infection has never been traced. Thorough flushing of any main after repairs are made in any section is a safeguard that ought to be more universally observed.

We print in this issue additional statements by experts regarding the condition of the fireproof buildings in Baltimore, and one point referred to by one of these experts, Prof. Ira H. Woolson, is deserving of more than passing notice. It is the temperature which was reached in this conflagration. Prof. Woolson expresses the opinion that it was not more than 1,500° to 1,800° in the fireproof buildings, judging from the condition of articles of brass, iron and other metals remaining in the offices. This opinion is substantially corroborated by the independent observations of Mr. Constable.

To the layman it may seem a point of small importance whether the average temperature in a conflagration is 1,500° or 2,500°; but as a matter of fact the whole modern fireproofing or fire-retardent system of covering the steel framework of buildings depends for its success upon the temperature attained in a fire. Heat a so-called fireproof building hot enough and for a long enough time, and the steel beneath its protecting coating of non-conducting material is sure to be heated to a point where softening and rupture will occur. Before the Baltimore fire occurred, any engineer would have been justified in expressing grave doubt as to whether a steel-frame fireproof building could withstand the heat of a conflagration. The experience at Baltimore, therefore, is distinctly reassuring. It should be added, however, that the steel-frame buildings at Baltimore were all office buildings. There is still room for doubt as to whether a steel-frame warehouse filled with inflammable materials would not succumb if its contents burned, regardless of the protection offered by fireproofing.

TRAIN ACCIDENTS IN THE QUARTER ENDING SEPT. 30, 1903.

We briefly noted on page 175 of our last issue the total casualties on United States railways reported by the Interstate Commerce Commission for the three months ending Sept. 30 last. The complete bulletin now at hand gives an interesting table of 29 train accidents occurring during the quarter, which were of especial interest either because of the casualties involved or because the accident was due to some cause which is instructive to place on record.

We reprint this table herewith, for it certainly is worth the careful study of any one connected with the railway service. It is pointed out by the commission and is well worthy of note, that only two of these collisions recorded occurred under the block system, and one of these was to a freight train running under the "permissive system," whose engineer was carrying a "caution card."

It is also worthy of notice, how many of these accidents are due to excessive speed. In two cases excessive speed caused derailment on curves. In one case the curve was 7° 24′ and the outer rail was elevated 7¾ ins. It is perhaps a fair inference from the use of such excessive superelevation that the road where this accident occurred was attempting to run fast passenger trains at a higher rate of speed than its tracks and general alinement justified. The other derailment (No. 25 in the table) is evidently that on the Southern Ry., near Danville, Va., which was illustrated and described by a special correspondent in our issue of Oct. 8, 1903, in which a fast mail train went over the side of a 75-ft. trestle, killing every person on board.

TABLE I.—CAUSES OF TWENTY-NINE PROMINENT TRAIN ACCIDENTS, JULY 1 TO SEPT. 30, 1903.
(R. stands for rear collision; B., butting collision; M., miscellaneous collisions; D., derailment; P., passenger train; F., freight and miscellaneous trains.)

Item.	Record No.	Class.	Kind of train.	Killed.	Injured.	Damage to engines, cars, and roadway.	Cause.
1	22	R.	P. and F	2	4	$1,530	Freight detained at station; inexperienced flagman went back with signal; returned to a point near caboose and went to sleep on track. Engineman and fireman of approaching train might have seen tail lights of freight 2 miles away.
2	21	R.	P. and P	1	20	2,000	Clear block signal given while the preceding train was still in block section. Signalman 20 years old.
3	13	D.	P	2	2	5,200	Passenger train, running 60 miles an hour, overran home and distant signal at crossing; engineman and fireman killed.
4	8	M.	P. and P	1	14	5,513	Collision at crossing; unsettled dispute between the roads as to responsibility.
5	6	B.	F. and F	1	3	5,745	Engineman fell asleep; fireman unfamiliar with road.
6	3	B.	P. and F	1	4	5,875	Passenger train ran 8 minutes ahead of time. Conductor and engineman said to have good records.
7	43	D.	F	2	1	6,100	Train became uncontrollable on steep descending grade; brakes inspected at summit and found satisfactory; track was wet. Trainmen reported as not chargeable with misconduct.
8	33	R.	F. and F	22	15	6,200	3 a. m. Two trains carrying circus; engineman failed to keep air brakes charged with proper pressure. (See further explanation in text below.)
9	41	D.	P	2	1	6,500	Excessive speed on curve of 7° 24'; outer rail elevated 7¾ ins. No passengers on train.
10	63	R.	F. and F	0	0	6,800	The engineman neglected to observe caution card delivered to him, and disregarded automatic block signal.
11	31	B.	F. and F	0	2	7,566	Operator failed to deliver telegraphic order; operator in service at this place 7 days; other places 2 years; age 23.
12	59	M.	F. and F	1	2	8,700	Collision at crossing, 4 a. m.; signal set at "stop," but did not show red; defective counter-weight.
13	68	B.	F. and F	0	3	10,000	Dispatcher sent telegraphic order reading 5.20 p. m. Operator copied it 5.30; dispatcher claims that when the order was repeated this error was corrected, but this the operator denies.
14	51	D.	F	0	0	10,226	Brakebeam dropped.
15	2	B.	P. and P	1	129	10,480	Improper flagging by eastbound train. Conductor, brakeman, engineman, and fireman dismissed for negligence.
16	23	R.	F. and F	0	0	10,500	Improper flagging; brakeman returned to his caboose and was killed; 22 years old; 8 months' experience.
17	54	D.	P	4	27	10,500	Front truck wheel of engine broke.
18	73	B.	F. and F	0	5	10,500	Train while waiting on side track lost right to road by becoming 12 hours late; conductor and engineman started out, forgetting this limitation.
19	52	D.	F	0	0	12,000	Broken flange.
20	34	D.	P	0	5	12,313	10 p. m. Bridge washed out by flood caused by "waterspout." Flood five times greater than capacity of waterway beneath track.
21	46	D.	P	3	2	13,000	Washout.
22	9	M.	P. and F	1	3	13,700	Work train on 4½% grade became uncontrollable and ran into the side of passenger train.
23	18	D.	F	0	1	15,000	Train became uncontrollable on steep grade; engineman "lost his air."
24	5	B.	P. and F	22	25	16,896	Conductor of freight misread telegraphic order; it read 20 minutes; he read it 1 hour and 20 minutes. Engineman took conductor's word and did not read order.
25	48	D.	Mail	5	0	18,100	Entire crew (all the persons on the train) killed. Too high speed on curve. Train fell 75 ft. Engineman not long in the service of this road, but knew the line and had had experience elsewhere.
26	29	B.	F. and F	4	4	18,109	Operator made mistake in copying telegraphic order. Dispatcher failed to discover error on repetition; two enginemen disregarted automatic block signal.
27	64	R.	F. and F	1	2	20,000	Careless running.
28	1	B.	P. and P	0	1	30,600	Conductor and engineman west bound misread telegraphic order.
29	4	B.	P. and F	4	60	33,770	Conductor and engineman of one train misread orders. They had a "19" order against "Second No. 1;" but read it "No. 1;" engineman was killed. Being on Form 19 the order was not read by the operator to the conductor and engineman.
			Total.....	80	335	333,423	

It is not infrequent to hear the claim made that high speed in railway service is as safe as moderate speeds; but such an idea is not only contrary to all reason, but is disproved by the study of actual statistics of railway accidents, such as those before us. An excellent illustration is Accident No. 3 in the accompanying table, where a train running 60 miles per hour ran past both the distant and the home signals at a crossing. Whether the engineer misread the signals or could not check his train soon enough after coming in sight of them is not stated, and makes little difference, for slower speed would have given him more time to correctly read the signals in the first place, as well as to stop his train after reading them.

Another striking feature of the table is the proportion of collisions due to failure of the train order system. If we may alter the old saying about a chain being no stronger than its weakest link, we may say that a chain is only safe when all the links in it hold, and each link in the transmission of orders from the dispatcher, through the telegraph operator to the conductor and engineer, is an opportunity for failure to occur.

TABLE II.—Average Frequency of Accidents to Moving Trains.

	Passenger Trains.	Freight Trains.
Collisions, 3d quarter, 1903.....	251	1,514
Derailments, 3d quarter, 1903...	140	1,158
Train Mileage for 1902	405,613,231	490,711,170
Average Mileage for quarter....	101,403,308	124,927,794
Miles run per collision.....	404,000	82,500
Miles run per derailment	724 300	107,700

As we stated last week, there were in the quarter 1,765 collisions and 1,298 derailments sufficiently serious to be reported. Collisions or derailments which cause no casualties to persons and do damage under $150 to railway property are not reported. It may be of interest to compare these figures of total collisions and derailments with the total train mileage, to see what distance a train will run, on the average, before it meets with collision or derailment. The train mileage figures for the quarter covered by these accident statistics are not yet compiled, so we will make our comparison with the last statistics available, those for the year 1902. The comparison is shown in the accompanying Table II. It will be seen that on the average a passenger train will meet with one collision in the course of 404,000 miles run and one derailment in the course of about 725 000 miles. Freight trains meet with collisions five times as often and with derailments seven times as often. This may fairly be said to indicate that there is five times as much carelessness in moving freight trains as in moving passenger trains, and this, it will be generally agreed, is a condition which ought to be remedied, not only for the safety of freight trains, but of passengers as well, for a large percentage of the collisions of passenger trains occur with freight trains. The fact that three times as many derailments occur from defects of rolling stock as from defects of track is one explanation for the more frequent derailments of freight trains.

A COMPARISON OF CIRCULAR AND RECTANGULAR ENGINE HOUSES.

The circular type of engine-house, or roundhouse, is distinctively characteristic of American railways, being almost exclusively used for both large and small structures. In European practice the rectangular type is generally used, but the few rectangular, or so-called "square," engine-houses in this country are mainly small and unimportant structures. Roundhouses are usually segmental, though they are occasionally built as complete circles, and in the latter case the inner wall might be dispensed with, the entire space (including the central turntable) being covered with one roof, dome-shaped or conical in form. This, however, is rarely done. While the rectangular design is but little used in this country it has some important advantages, especially in regard to economy of space occupied, and at the February meeting of the Western Railway Club Mr. Geo. P. Nichols described a new design of rectangular engine-house in which two rows of short stub tracks with pits, are served by a transfer table running through the middle of the building. An abstract of this paper is given in another column. Our issue of Aug. 22, 1901, contained a very complete article on "Roundhouse Construction and Equipment," but that, as the title implies, dealt exclusively with the circular type of house. In the present article, however, we propose to discuss the comparative merits and advantages of the circular and rectangular plan.

The paper by Mr. Nichols, above mentioned, has brought up again this question of the relative merits of circular and rectangular engine-houses, a subject which has slumbered for some years past, but which is one of considerable importance, as affecting the space occupied and the facilities offered. In our issue of Oct. 19, 1889, appeared a paper on railway shops by Mr. J. Davis Barnett, Assistant Mechanical Superintendent of the Grand Trunk Ry., in which reference was made to the common English type of rectangular engine-house, with parallel longitudinal tracks and exits at each end. An example cited was an engine shed at Montreal, on the Grand Trunk Ry.; this was 76 × 282 ft., with five tracks accommodating 25 long engines with tenders. Another, on the same road, at Lindsay, was 62 × 250 ft., with two through tracks (having continuous ashpits) for 10 running engines, and one through track for engines under repairs, being washed out, or waiting under steam for trains. In our issue of May 9, 1891, in describing the shops and yards of the Union Pacific Ry., at Cheyenne, Wyo., we presented a plan showing that a rectangular building with five parallel tracks 280 ft. long would give the same capacity as the 30-stall roundhouse, but with a great economy in space covered. With exits at both ends, no more than two engines would have to be moved to get at any engine, but as a matter of fact, with a little systematic care in placing the engines, there need be little handling of the engines. In the book on "Railway Construction," by Mr. Wm. H. Mills (Chief Engineer of the Great Northern Ry. of Ireland), published in 1898, it is stated as follows:

> Circular and semicircular running sheds—or engine-houses—are not so often adopted now as formerly. Although compact and accessible in theory, they possess the great drawback that when the turntable in the center becomes deranged, none of the engines in the building can be taken out until the turntable is again put in working order. This objection is considered to be of so serious a nature that running-sheds are now almost always constructed of rectangular form.

A general objection made to the longitudinal track arrangement has been the trouble and extra movement required in getting out engines which are near the middle of the house, but in practice, and with a proper system of operation, this does not prove to be as serious as it might at first sight appear. In one particular case, where the local conditions did not admit of running the tracks through the building, a transfer table was placed at the middle of the building, running transversely across it and connected with an outside track. This was in fact a partial anticipation of Mr. Nichols' plan. In all these engine-

houses, however, the tracks run lengthwise of the building, and this is common practice abroad. The plan for rectangular houses suggested by Mr. Walter G. Berg, Chief Engineer of the Lehigh Valley Ry., provides for short transverse tracks through the building, thus avoiding the difficulty of handling engines on long tracks. In this connection we quote the following remarks from Mr. Berg's book on "Buildings and Structures of American Railways:"

Large square engine-houses are sometimes preferable, owing to the shape of the ground space available for the house and track approaches, and also where an engine-house is to be used for considerable repair work in addition to housing engines. Large square houses have marked advantages under certain conditions, and merit more attention in practice. An engine-house for a limited number of engines consists usually of a rectangular building, with a length in excess of the largest engine used, and width dependent on the number of tracks. Sometimes it is made long enough to accommodate two or more engines on the same track; it is not good practice to place more than two engines in one stall, and even then there should be doors at the rear of the house, as otherwise it would be difficult to get out the rear engine if the one in front did not have steam up. The approach is usually by a ladder track. For very large square engine-houses, a transfer table is used with good results, especially where the transfer table is located some distance from the house, so as to give a space for engines to stand between the house and the table in case of fire.

The advantages of a square house with special track approach are, that delays from breakdowns, blockades, or loss by fire are not so liable to occur; the house is cheaper and simpler to build, especially for a small house with only a few stalls; and the engine-house foreman will have a better oversight over the whole building than in a roundhouse, which is quite important where there is considerable work and repairs to be done around the engines. But the disadvantage of a track approach is that it takes up considerable ground space.

The advantages of a square house with a transfer table are, that it takes up proportionately the least ground space of any system; a cheaper and simpler house can be built; a better oversight had of the work going on in the building than in a roundhouse; and the extension of the building indefinitely is only limited by the land available. For a small house the construction of a transfer table would not pay. The disadvantages are, however, that breakdowns are more liable to cause a blockade, and in case of fire the engines cannot be removed as expeditiously from the house as in a house with track approach, although by use of a space between the house and the transfer-table, as above described, considerable can be done to eliminate this latter objection.

The advantages of a roundhouse with a turntable are economy of ground-space, as compared with a large house with a track approach or a square house with tracks leading to a turntable. A good light can be thrown on all engines, and the width of the stall is greatest at the outer wall, so that the best light and the most floor surface around the engine exist at the head of the engine, as engines almost invariably run into a roundhouse head first. A roundhouse can also be built in sections at a time, without in any way harming the general design, as the wall at the end of each section, if built solidly, can remain as a fire-wall. The objections to a roundhouse are, that the building, as compared with a square house, is more costly and complicated, and a general oversight of the work going on in the house is not as easy as in a square house. A breakdown at the turntable or on the main track leading to the house might cause a serious blockade, and in case of fire a roundhouse in combination with a turntable, especially a closed roundhouse, even under the best conditions, is not much better than a fire-trap.

While roundhouses with the entire space roofed over, to form a circular rather than an annular building, are but little used, it will be of interest here to note some large roundhouses of this kind built by the Eastern Ry. of France, in 1892, at Noisy-le-Sec and at Troyes-Preize. At both of these places there are two roundhouses, with a repair shop between them. The roundhouses form complete circles, 230 ft. radius, and are composed of steel arch ribs resting on pin bearings on low pedestals, and with their tops butting against a circular girder carrying the ventilator. The clear height is 84 ft. 4 ins., or 108 ft. 3 ins. to the top of the ventilator. In the center is the turntable, from which radiate 52 tracks. A diametrical track runs through both roundhouses and the shop between, and each house has also three of its radial tracks extended through the sides to connect with the yard tracks. A circular brick wall is built just outside the pedestals of the steel ribs, and light steel frames extend from this to the structural framework to carry the lower part of the roof. The cost was $54,974 (or $1,696 per stall), as compared with $50,820 (or $1,588 per stall) for the older plan of an annular building. The extra cost was thought to be warranted by several advantages: 1, all handling of engines, cleaning, repairs, etc., is done under cover; 2, there is more space around the engines; 3, the lighting is better; and 4, the engines are far enough from the walls to permit of cleaning the tubes.

Among the very few instances of rectangular engine-houses in this country, may be noted the following: 1, a brick building, 53 × 68 ft., on the Erie Ry. at New Castle, Pa., having three tracks; 2, a brick building, 124 × 132 ft., on the Lehigh Valley Ry. at East Mauch Chunk, Pa., this has nine tracks (13 ft. c. to c.) running through it, each taking two engines; 3, a frame building, 37 × 140 ft., on the same railway at Orwigsburg, Pa., this has two tracks, each taking two engines. A special design of rectangular engine-house on the same railway at Towanda, Pa., is 63 × 183 ft., with nine tracks entering at an angle of 46 °. This arrangement was adopted to utilize a limited space adjacent and parallel to the main tracks. The tracks are 13 ft. c. to c. on the square, or 18 ft. on the skew, and the opposite corners of the house are used for supplies and repair work. The only adoption of the rectangular system on a large scale, of which we have any knowledge, is that of the Terminal Railroad Association at St. Louis, Mo., as mentioned by Mr. Nichols. Here a great number of engines are handled, including every engine that enters the great union station. The plant consists of three houses in a row with parallel tracks (14 ft. c. to c.) extending through the three houses, while in the two open spaces between the houses are transfer table pits, each with two 75-ft. 150-ton transfer tables. A third table, with shorter travel, will be in front of the end house, and will transfer engines from the approach tracks to the house tracks. The three houses will have capacities of 17, 21, and 24 engines, or 62 engines in all; each track holds two engines (except a few tracks holding one engine only). As the various engines belong to a number of different roads, their handling is more complicated than would be the case if all were owned by one road, since each road has its own train service to provide for. The arrangement of the three engine houses and transfer tables gives much better facilities for handling a number of engines under these conditions than could be obtained with a single large house and one turntable or transfer table.

Including Mr. Nichols' proposed plan, already noted, we have four arrangements of tracks for engine houses: 1, radial tracks in a circular or segmental building; 2, longitudinal tracks in a rectangular building; 3, transverse tracks in a rectangular building; and 4, diagonal tracks in a rectangular building.

The approach to the radial tracks of a roundhouse is uniformly effected by means of a turntable from which the tracks radiate, and one or more through tracks are usually provided, connecting with the yard tracks. The approach to the parallel tracks of a rectangular house may be by means of a turntable or a diagonal ladder track, either of which plans requires more or less space outside the house. In the new plan proposed by Mr. Nichols, however, the approach would be greatly simplified as to arrangement and space occupied. There would be merely one or more straight tracks entering the buildings, and the transfer table inside would then carry the engines to the desired tracks or pits. The arrangement would be very similar to that of some locomotive erecting shops, with the substitution of the transfer table for a traveling crane. One objection to this system is that it does not provide for turning the engines and that the transfer table would be an additional item of equipment. In some cases a Y-track might be used for turning engines and cars, or it would be quite practicable to devise a transfer table which could drop a center pin or take a center bearing in some way, and then revolve on this center, the end of the pit being made semicircular. It is often urged that the breakdown or failure of a turntable would effectually tie up all the engines in the house, and this would be the case also with the transfer table. But with modern substantial machinery such accidents are extremely rare, and the transfer table, being always under cover, would be more likely to be kept in proper condition than the outdoor turntable. While this emergency is to be considered as a possibility it is not likely that it would be given very much weight, and the comparison between the circular and rectangular house may therefore be made on the basis of space required and general convenience and efficiency.

As far as damage to the engines in case of fire is concerned, the turntable and transfer table would be about on the same basis as far as removing the engines quickly is concerned, and even with separate track approaches there would be trouble in removing dead engines. With a space wide enough for an engine to stand between the house and the table, engines under steam could be run out, and some of the dead engines perhaps hauled out by a power capstan. But this leads us to the question of fireproof construction of roundhouses. Considering the danger of fire and the serious results which might be involved it seems rather strange that frame construction is so largely used. Even at the new shops of the Chicago, Rock Island & Pacific Ry., described in our issue of Feb. 11, the roundhouse has brick walls with wooden interior posts supporting a wooden roof framing, while the main shop buildings are of brick and steel construction. It has been objected that the smoke and gases would cause rapid corrosion of steel work, but steel roof trusses have been quite generally used in roundhouses, and there should be little difficulty in protecting the steel with tile or concrete. In fact, it would be an easy matter to build a two-story engine-house, using the upper floor for stores and supplies, or for engine repair work. In this case the roof of the engine-house would consist of a steel framing carrying (and enclosed in) the tile or concrete floor of the store house, as in ordinary methods of building construction. Individual concrete flues might be carried up to the roof from the several stalls, or the smokejacks might be connected by pipes (with suitable dampers) to a large flue. This would be specially convenient in combination with a blower or ventilating system, as already adopted in a number of roundhouses.

The heating of a rectangular house, requiring very few doors, would be much easier and more economical than a roundhouse requiring a door for every stall. The few doorways might be fitted with rolling or sliding doors practically tight fitting. For a roundhouse, however, the expense of rolling doors generally leads to the use of ordinary wooden doors, which must swing, as there is no room for sliding doors. There is often difficulty in handling these doors, and in winter they usually admit much more air than is required for ventilation, the house being both cold and drafty.

Finally, in regard to the space occupied, we may consider a circular and a rectangular engine-house with 50 stalls. A roundhouse with 80-ft. stalls, 80-ft. space between the house and turntable pit, and a 70-ft. turntable, making a total diameter of 390 ft., will cover an area of 119,460 sq. ft. A rectangular house with two rows of 80-ft. stalls one on each side of a 70-ft. transfer table, and with 25 stalls in each row, 15 ft. c. to c. (making a building 375 × 230 ft.), will cover an area of 86,250 sq. ft. The rectangular house would also be placed more conveniently and economically in the yard space available, and the approach might also cover very much less space, as already noted. From all that has been said it will be seen that the rectangular engine-house presents many advantages, and it will be of interest to watch and see if this plan is adopted in the construction of new division of the terminal plants or in the rearrangement of existing plants.

LETTERS TO THE EDITOR.

A Simple Formula for Reinforced Concrete Beams.

Sir: The simple formula for reinforced concrete beams given in your issue of Feb. 11 is defective in several respects. First, the tensile value of concrete in general construction is so very uncertain that good practice ignores it entirely. Secondly, the moment area of the steel is not equal to the depth of the reinforcement below the top of beams, but to the distance of the center of ten-

sion from the neutral axis. Since the position of the neutral axis is dependent upon the modull of elasticity for the steel and for the concrete, together with the area of the steel it is evident that additional factors to those mentioned must be considered in providing for bending moment. This will involve a flight to higher regions of thought, but the atmosphere will prove wholesome to any civil engineer contemplating reinforced concrete construction. An appreciation of this fact will result in fewer failures and collapses of a much abused construction.

Yours truly, Cincinnati.

Cincinnati, O., Feb. 14, 1904.

Making Drawings on Tracing Cloth.

Sir: Considerable work can be saved when detail drawings are desired in ink on tracing cloth by first making the detail pencil drawing direct on the rough side of the tracing cloth instead of on drawing paper and then tracing the same with the drawing ink. The pencil drawings can then be removed by saturating a flannel cloth in ordinary gasoline and applying it to the surface of the tracing cloth with a little friction. This will readily remove all pencil marks and will not streak or disfigure the tracing cloth as an ordinary ink eraser would.

John J. Reinhold.

Marietta, Pa., Feb. 24, 1904.

(In case the detail drawings are intricate and require a large amount of time, it may be preferable to make them on paper, which is more convenient on the whole for pencil drawings than tracing linen. If a rather thin, smooth paper is used, blue prints can be made directly from this drawing.—Ed.)

Rules for Dropping Decimal Places.

Sir: Allow me to suggest the following rule for dropping the 5: When the next figure to the left is 0 to 4, inclusive, drop the 5; when the next figure is 5 to 9, inclusive, drop the 5 and increase the next figure by 1. This keeps the correct value of the decimal if it becomes desirable to drop additional figures. Yours truly,

C. H. Pool.

15 Dey St., New York, Feb. 25, 1904.

Sir: My rule for the right-hand figure after dropping the 5 is always to leave the remaining figure even. Thus, .785 becomes .78, while .795 becomes .80, and .735 becomes .74. This avoids the trouble of making an exception by retaining an extra figure in a few cases where the number ends in 5, and in the long run gives no tendency for an error in either direction. Yours truly,

R. S. Hale.

229 Devonshire St., Boston, Feb. 25, 1904.

Subscriptions to the "Journal of the Association of Engineering Societies."

Sir: A correspondent writes:

I wish also to enquire about the statement made by a correspondent in Engineering News of recent date, that the proceedings of the societies composing the association could be obtained, as I understand it, by persons not members.

From this it would appear that a considerable number of members of the engineering profession may be uninformed in the premises, and I should like to remove any misapprehension on this score. Inasmuch as the Association of Engineering Societies is conducted, not for profit, but simply for the dissemination of knowledge respecting engineering, you may find it proper to give space to the statement that the "Journal" of the Association, in which are published the papers and proceedings of the societies (now eleven in number, and aggregating about 1,600 members) which compose the Association, is open to general subscription at $3 per annum.

Yours truly, John C. Trautwine, Jr.,
Secretary.

257 So. 4th St., Philadelphia, Feb. 24, 1904.

An Auger for Boring Ice for Soundings.

Sir: Under the heading of "Notes and Queries" in your issue of Feb. 18, "L. E., Chicago, Ill," asks if there is an appliance in the market for boring holes in the ice to be used in connection with the soundings.

This department during the past winter has tried several appliances for cutting holes in the ice for use in soundings on the Mohawk and Hudson Rivers in connection with the plans for the Barge Canal Improvement, and our experience has proven that the best appliance for cutting such holes is an auger 2½ ins. in diameter with a crank attached for use by one man.

The auger used is made by the Snell Mfg. Co., Fiskdale, Mass., and in small orders costs $5.50 each f. o. b. factory. The ice our survey parties have been working on runs from 22 to 30 ins. in thickness, and the average time of boring each hole by one is one minute.

Respectfully yours, Wm. B. Landreth,
Resident Engineer.

Barge Canal Office, Albany, N. Y., Feb. 24, 1904.

(We have also a reply from Mr. R. Bickeldike, of Montreal, stating that a satisfactory machine was used by the Montreal Harbor engineers in 1895.—Ed.)

Stadia Work Without Stadia Cross Wires.

Sir: Stadia measurements can be made without the use of stadia wires in the following manner: Set two targets on a rod 10 ft. apart. Hold rod perpendicular on point,and read the vertical angles to upper and lower targets. Their difference gives the rod angle. In Table I., opposite this angle find the approximate slope distance of rod. Multiply this distance by the distance and elevation numbers in Table II. opposite angle reading of lower target, and add the upper constant numbers, if the angle readings are down, or subtract if up. This will give the correct horizontal distances and elevations to use.

TABLE I.

Rod angle.	Approx. slope distance.
2° 22′	241.96′
3° 02′	188.71′
4° 56′	115.85′

TABLE II.

Lower target angle.	Hor. Distance.	Elevation.
1° 42′	0.30 .9991	0.01 .0297
.. ..	...	...
20° 30′	3.28 .8774	1.23 .3280

Example 1.

U. target — 15° 34′ } Rod 4° 56′.
L. target — 20° 30′ }

Hor. dist. 115.85 × .8774 + 3.28 = 104.93 ft.
Elevation 115.85 × .3280 + 1.23 = −39.22 "

Example 2.

U. target — 18° 08′ } Rod 2° 22′.
L. target — 20° 30′ }

Hor. dist. 241.96 × .8774 + 3.28 = 215.57 "
Elevation 241.96 × .3280 + 1.23 = −80.59 "

Example 3.

U. target + 4° 44′ } Rod 3° 02′.
L. target + 1° 42′ }

Hor. dist. 188.71 × .9991 − 0.30 = 188.24 "
Elevation 188.71 × .0297 − 0.01 = + 5.59 "

The slide rod below lower target is supposed to be set to transit height. Or this distance can remain constant, say 4 ft. high, enough for that target to be always in plain sight,and subtracted from transit height,and the difference corrected in elevation. By this method there is no confusion in calling out numbers; also the focal distance correction is omitted. Isaac Dox, C.E.

84 Ontario St., Lockport, N. Y., Feb. 15, 1904.

The Use of "Studs" for Marking Sewer Branches.

Sir: I have noticed in your paper recently, articles on the use of "studs" for the purpose of marking the location of sewer branches. I have used them for several years. What I consider their most important use does not seem to be touched upon by your correspondents; that is, the prevention of the liability of the branch being struck by the rammers when compacting the earth alongside and above the pipe.

Yours respectfully, H. P. Farrow.

Centre Belmont, Me., Feb. 19, 1904.

Sir: Several letters to the Editor, printed in Engineering News of recent dates have been in regard to the placing of markers in sewer trenches over the branches.

If they are to be a feature of sewer specifications, a word of caution is to be given to the young engineer who has the work of locating the branches for future use and for the making of the plans. He will need to beware of depending upon such markers when making his measurements. After a branch has been covered with the backfilling, if a measurement has not been made to it from some fixed object, its location can be found only by uncovering it. If a scantling is placed upright by a branch it is almost sure to be knocked down, and then, the branch being covered, it will be set up again without close regard to its proper location.

In laying out the work of making an opening down to a branch, a point vertically over it must be known if the work is to be done with economy. So, if the top of a scantling is to be the starting point, some means must be taken to hold it vertically in its proper place while the trench is being filled. The ordinary sewer workman is not to be depended upon to do this. The expense, if the marker is to be of any value, will hence be much more than the cost of the material.

In conclusion, it is of the first importance that the inspector shall make and record a measurement that is correct within 3 or 4 ins. from a fixed and easily found point (a manhole center is the best for this, probably) to a point that is on the same vertical line as the branch.

If it is found that this is not being done, it would probably be a good plan not to provide for the placing of a marker, but to raise the assistant's pay by an amount equal to its cost, and if he did not do better then, discharge him and try another man.

It is doubtful if the standard of engineering is to be raised by paying out money for sawmill work and lumber instead of to the assistants for careful and accurate work.

Yours truly, Geo. E. Manning.

New London, Conn., Feb. 12. 1904.

Salaries of Engineers.

Sir: In connection with the letter of T. F. W., appearing in last week's issue of your magazine, I wish to have a few words to say.

In the first place, is it not the first duty of an engineer to take pride in his profession? If he cannot do this, does it not go to show that either he or his profession is in some way at fault? Is not the true worth of an article of commercial or professional use based upon its intrinsic value? Then, if an engineer rates his salary on a par with that of a dry-goods clerk, an assistant bookkeeper or a second-class bartender, does he not do injustice to the profession?

It does not seem to me that "idle times" has very much at all to do with the question, unless the engineer is to be classed with the labor union. An engineer's work may not cover thirty days in the month or twelve months in the year, but if circumstances make it necessary, as it does in most cases, that the engineer be employed by monthly or yearly salary instead of acting as an independent practitioner as we find the doctor, the lawyer and even the architect, should not his salary be based upon the value of his work, rather than the time he is working, or the availability of men just as good? The term "value of work," it is true, can bear endless discussion, but just let the engineer place his work side by side with that of the average man of commercial business, or other professions, and let him compare his work and theirs, labor for labor, merit for merit, use for use, time for time, and compensation for compensation. If in both cases the first four conditions agree, the last never will; if the last agrees, and even two of the first four, the case will be extraordinary. Do these comparisons need lengthy discussion?

Then are we to judge from what we see advertised and discussed that the engineering profession is an inferior profession, or are we to judge that these circumstances occur on account of a lack of unity among the members and because there are among the ranks of the civil engineer too many who are ambitious to nothing beyond the mediocre, and who have no spirit further than that to hold their job, whatever it may be?

The writer is a young engineer, perhaps too young to judge professional ethics to the fullest and truest extent, and while he believes in the profession, it has been hard to look at such things in any other light. We may notice that T. F. W. in his letter says that he has been Chief Engineer, etc. It is just such a spirit as his letter shows that is the cause of so many has-been's in the ranks, and it is the engineer's task alone to remedy the condition.

Very truly yours. R. S.

Brooklyn, N. Y., Feb. 28, 1904.

Logarithmic Functions of Small Angles.

Sir: In your issue of Jan. 28 Mr. A. I. Frye reminds your readers of a convenient formula for determining logarithmic functions of "small angles." Unfortunately, he does not give the limits within which the formula is applicable. And, apropos, I would call attention to the indefiniteness attaching to such expressions as "small angles," "very small angles," "very small values," which are often used even by pure mathematicians, without specifying any fixed values beyond which the formulas applicable to "small values" do not hold. In works on geodesy, accurate surveying and astronomy it is frequently stated that, for "very small angles" the sine may be taken equal to the arc; but the reader or student is not told whether he may apply the principle to an angle of 10′, or 30′, or 1°; in short, he is left to find out for himself what the writer means by a "small angle." Much would be gained if all approximate formulas, especially those intended for the use of the practical engineer, were accompanied with a definite statement of the limits of their applicability.

In what follows, A will denote an angle found in the table, and A + d an angle greater than A, but less than the angle next higher than A in the table. Thus, if the angle whose logarithmic functions are required is 2° 46′ 37.5″, and the table is a 1″-table, then A = 2° 46′ 37″, and d = 0.5″. If the table is a 10″-table, A = 2° 46′ 30″, and d = 7.5″. If the table is a 1′-table, A = 2° 46′, and d = 37.5″. The angles A and d, when reduced to seconds, will be denoted by A″ and d″, respectively.

Permit me to state that the formula used by Mr. Frye is not, as you remark, founded on the assumption that for "very small angles" the sine may be taken equal to the arc, but on the fact that, within the limits presently to be specified, angles are proportional to their sines. Within those limits we have,

$$\frac{\sin (A + d)}{\sin A} = \frac{A'' + d''}{A''},$$

whence

$$\log \sin (A + d) = \log \sin A + [\log (A'' + d'') - \log A'']. \quad (1)$$

The limits of applicability of this formula are as follows:

(1) For a 7-place, 1″-table (that is, one in which angles are given from second to second), the formula applies, with a possible error of one unit in the last figure, to all angles usually given in such tables; that is, up to 5°;

(2) For a 7-place, 10″-table, the formula applies, with a possible error of one unit in the last figure, to angles not greater than 55′;

(3) For a 5-place, 1′-table, the formula applies to angles not greater than 4° 27′.

Within the limits to be specified below, the sine of an angle may be taken equal to the arc, or to the radian measure of the angle. In this case we may write for an angle B

$$\log \sin B = \log (B'' \sin 1'') = \log B'' + \log \sin 1.'' \quad (2)$$

The limits of applicability of this formula are as follows:

(1) For a 7-place table, the formula applies exactly to angles not greater than 1′ 58″, and may be written,

$$\log \sin B = 6.6855749 + \log B''. \quad (3)$$

For angles between 1′ 58″ and 4′ the formula applies within one unit of the seventh order; or, exactly,

$$\log \sin B = 6.6855748 + \log B''. \quad (4)$$

(2) For a 5-place table, the formula applies to angles not greater than 40′, and may be written,

$$\log \sin B = 6.68557 + \log B''. \quad (5)$$

The example that Mr. Frye works out by means of formula (1) can be much more readily worked out by means of formula (3). In this case, B = 1′ 23.5″, and, therefore, B″ = 83.5″. Applying formula (3), we have

$$\log \sin 1'' = 6.6855749$$
$$\log 83.5 = 1.9216865$$
$$\log \sin B = 6.6072614$$

The result differs from Mr. Frye's by a unit of the seventh order. Such small discrepancies are to be expected, on account of the approximate character of the seventh figure. It is interesting to notice that if the logarithms of 83.5 and 83 are taken to 8 places, the result obtained by formula (1) (the one used by Mr. Frye) will be identical with the one just obtained.

Formulas similar to those here given, but not applicable within exactly the same limits, can be used for logarithmic tangents. It is, however, better to calculate the logarithmic tangent by the general relation

$$\log \tan K = \log \sin K - \log \cos K.$$

Gauss's five-place, one-minute tables, and nearly all those founded on them, have a table of corrections by which the logarithmic sines and tangents of angles less than 3°, and containing seconds, can be determined. In case of emergency, however, or if the manner of using the corrections is forgotten, as often happens to one not employing them frequently, formula (1) may be used to advantage; although it should be borne in mind that for angles greater than about 2° 30′, the usual method of interpolation gives close enough results.

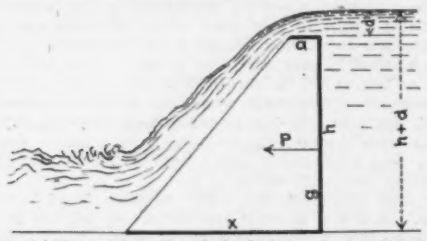
Yours very truly, Antonio Llano.

Scranton, Pa., Feb. 13, 1904.

The Stability of Surcharged Masonry Dams.

Sir: The questions raised by Mr. John C. Trautwine, 3d, in your issue of Feb. 11 regarding the stability of surcharged masonry dams are very interesting and merit careful study. The theoretical problems involved, depending as they do upon simple hydrostatic principles, are easily reached by calculation.

The figure represents a trapezoidal spillway of height, h, over which water is passing, the surface of the water



Sketch Illustrating the Calculation of the Stability of Surcharged Masonry Dams.

in the reservoir being at the height, d, above the level of the lip of the spillway.

To ascertain the amount of pressure against the back of the wall, the best plan will be to consider the vertical surface = h, as subjected to a hydrostatic pressure due to the head h + d. We then recur to the general law of hydrostatic pressure, which reads:

The total pressure in pounds on any plane submerged surface, of whatever shape, and whether vertical, horizontal or inclined, is equal to its area in square feet multiplied by the vertical distance of its center of gravity in feet below the surface of the water, and by 62.50. The direction of this pressure is at right angles to the plane of the surface pressed.

Confining our calculations to a unit length of dam, the pressure, P, is, by the above rule, making desirable reductions:

$$P = h\ (2\ d + h)\ 31.25 \quad (1)$$

This formula gives the total pressure in all such cases under the given assumption as are illustrated by the figure.

Next, it is necessary to find the point of application of this pressure against the wall, in order to calculate the overturning moment about the outer toe. For this we recur to the general law for the center of pressure upon submerged surfaces, which reads:

The center of pressure is on the line passing through the center of gravity of the prism of water pressing against the surface, and is at the point where this line intersects said surface.

In the present case what we want to know is the height, g, above the inside foot of the wall at which the pressure is exerted, because this distance multiplied by the amount of pressure given by (1) will be the required moment. It is readily shown by calculations, which will not be repeated here, that for the assumed conditions this distance is:

$$g = \frac{h}{3}\left(\frac{3\,d + h}{2\,d + h}\right) \quad (2)$$

The desired moment, M, is obtained by multiplying (1) and (2) together. Performing indicated operations and reducing we have:

$$M = 10.42\ h^2\ (3\ d + h). \quad (3)$$

This is the standard formula for the assumed conditions shown in the figure.

APPLICATION.—In the figure let h = 60 ft. and d = 8 ft. Then, applying (3):

$$M = 10.42 \times 3{,}600\ (24 + 60) = 3{,}151{,}008 \text{ ft.-lbs.}$$

This is the moment, in static foot-pounds, tending to overturn the dam at this point. Let us now see what dimensions the dam should have to resist it. In view of shocks and jars, due to the falling water, a factor of safety of 3½ will be none too much, and the best way to apply it is to at once multiply the moment by this coefficient, which will give us $3151008 \times 3.50 = 11028528$. As the density of the masonry will be a factor in the calculation, it will be best to get rid of it at once by dividing this quantity by the assumed density, say 135 lbs. per cu. ft., which reduces the value of M to the practical factor, m, thus:

$$m = \frac{3.5\ M}{135} = 81693 \text{ ft.-lbs.}$$

The static moment of resistance of the dam must be equal to this figure. To arrive at this, we must assume a top width, a, for the trapezoid, and then calculate the bottom width, x, which will give the proper stability. By a simple calculation, which will not be repeated here, the general formula in this case is:

$$x = -\frac{a}{2} + \sqrt{\frac{3\,m}{h} + \frac{3\,a^2}{4}}. \quad (4)$$

In the above the double sign of the radical is omitted, as evidently only the positive sign applies.

Assume a = 10 ft. Then

$$x = -5 + \sqrt{\frac{3 \times 81693}{60} + \frac{300}{4}}.$$

$$x = 59.50 \text{ ft.}$$

Showing that at this point the dam, or spillway, should have a base practically equal to its height.

For the rest of the dam, which is subjected only to the pressure of quiescent water, simpler processes will suffice. If 8 ft. is the maximum depth of water which it is anticipated will go over the spillway, we may suppose that the crest of the dam itself might be carried 2 ft. higher, or 10 ft. above the spillway. This would make the total height 70 ft. Theory and practice show that from ⅔ to ¾ of this height are amply sufficient for the base. Therefore, we may take it at 50 ft. It is probable that the dam proper would be built to this dimension, and the face of the spillway reinforced with steps, giving it a base of 60 ft., according to our calculations.

The above data were assumed simply to illustrate the rules. Practically, so deep a wave as 8 ft. over a 60-ft. dam should be avoided if possible, by increasing the length of the spillway.

As regards the possible formation of a vacuum between the sheet of falling water and the face of the dam, I do not believe that any fears need to be entertained from this source. The violent commotion in the water would surely prevent the occurrence of a water seal, and the effect of a vacuum, even supposing it could be produced, would certainly be to draw the sheet of water down to the face of the dam, thus destroying the vacuum as fast as it was formed.

What the double effect of the falling sheet of water upon the dam might be by pressing it down by its weight on the one hand, and dragging it along by its dynamic impulse on the other, it would be hard to say. The depth of wave should be kept as low as possible by lengthening the spillway to the extreme limit. Considerable expense would be justified in keeping d, in the figure, down to 10% of h. Where a deep wave is unavoidable, increased mass must be added to that portion of the dam over which it falls. In such cases, a well riprapped earth fill, placed against the back of the dam, is a very efficient and comparatively cheap means of deadening the vibration of the masonry under the shock of the overflow. It adds to the mass of the dam, of which it may be considered as forming a part. No more advantageous use can be made of the material excavated from the foundation pits than placing it in this embankment.

E. Sherman Gould.

Yonkers, N. Y., Feb. 15, 1904.

A TRANSPARENT TRIANGLE WITH OPAQUE EDGE.

A new thing in draftsmen's triangles has recently been brough out by the firm of T. Altenedder & Sons, of Philadelphia. It is a transparent celluloid triangle in the edges of which a narrow strip of black has been inserted. This makes the edge of the triangle stand out clearly and eases the strain on a draftsman's eyes in setting the triangle edge to coincide with a line, particularly when working in poor light. The accompanying cut makes the idea clear. It will be seen that the advantage of the ordinary transparent triangle that the drawing is left visible is retained here.

TYPHOID FEVER AT WATERTOWN, N. Y.

By Weston E. Fuller.*

The prevalence of an unusual amount of typhoid fever in Watertown was first made known by the local papers about the middle of January. The first official notice was given out by the Board of Health after a meeting held on Feb. 1. This statement brought out the following: that 180 cases of typhoid had been reported by the physicians during the month of January; that an investigation was to be made at once; and that people were advised to boil all water used for drinking purposes. The investigation was started shortly after.

On Feb. 8, in view of the fact that 60 more cases had been reported, the Board of Health unanimously passed a resolution authorizing the health officer, Dr. E. S. Willard, "to employ a sanitary expert at once to investigate the situation, and to take such measures as may be reasonable and necessary to eliminate the epidemic."

Dr. Willard at once applied to the State Department of Health for such an expert. On Feb. 13, Prof. Olin H. Landreth, Consulting Engineer, State Department of Health, arrived in Watertown, spending that day in examining the situation and in advising with the local authorities.

Acting under Prof. Landreth's advice, the local authorities took the following steps: Postal cards were sent to all families in the city, warning the people to boil all water used for drinking, or for the washing of vegetables to be eaten uncooked, or for the washing of dishes; the investigation of all reported cases of typhoid in the city was continued on more complete lines; the investigation of all possible causes of pollution of the water supply was continued and extended; other data in regard to weather conditions, etc., were gathered.

In brief, the results of the canvass in the city are given in the accompanying table.

Total number of cases of typhoid reported (to Feb. 18), 350.

Date of indisposition.	No. of cases.	Date of deaths.	No.
December	12	Jan. 11 to Jan. 15...	1
Jan. 1 to Jan. 5.....	24	" 16 " " 20...	6
" 6 " " 10.....	23	" 21 " " 25...	1
" 11 " " 15.....	45	" 26 " " 30...	1
" 16 " " 20.....	62	" 31 " Feb. 4...	2
" 21 " " 25.....	38	Feb. 5 " " 9...	3
" 26 " " 30.....	41	" 10 " " 14...	7
" 31 " Feb. 4.....	38	" 15 " " 18...	3
Feb. 5 " " 9.....	28		
" 10 " " 14.....	13		

Note.—As this canvass included only cases reported to the health office, up to Feb. 18, the numbers for the last dates will undoubtedly be considerably increased.

In nearly all cases, city water had been used by the person before being taken ill. No great

*Resident Engineer, Watertown Filtration Plant.

number of cases occurred among people using any one well. The milk supply to the cases was very evenly divided among 38 dealers. The dairies supplying these dealers were of a much greater number and were widely distributed. The cases were scattered over the entire city.

The results seemed to show only one possible cause for the epidemic—the city water supply.

Watertown takes its water supply from the Black River, which has a drainage area of some 1,875 sq. miles. 78 sq. miles of this area lies between Watertown and Carthage. The intake is from a basin located on one side of an island; the entire flow of the river being on the other side of the island. This basin is from ½ to ¾ of a mile long, and from 200 to 600 ft. wide. It is of no great depth, probably not averaging over 8 ft. The ice has formed from 2 to 3 ft. thick over it, thus further limiting the chance for sedimentation. No method of filtration is used at present. The water flows by gravity for about half a mile to the pumping station, and from there is pumped to the reservoir. The city is supplied by gravity from this reservoir.

The writer has been personally engaged in the inspection of the watershed. As far as could be learned there have been no cases of typhoid above the intake, nearer than Black River village, 4½ miles from the intake. Here there have been at least five cases—the first starting during the last of December and the other four during the first half of January. Black River has a population of about 1,000. It has no sewerage system.

No cases were found at the next two villages, Felt's Mills and Great Bend. At Deferiet, however, a village of about 1,000 population, there have been at least 15 cases during the fall and winter. One case occurred in September; the second cases started during the first half of December; two other cases started during the last half of December; the others followed during January and February. Deferiet has a water supply from Black River and a sewerage system emptying into the river. It is about 13 miles above the Watertown intake.

At Carthage and West Carthage, there have been at least 15 cases ranging from September to the present time. There is no public sewerage system in Carthage, but there are several private sewers.

Above Carthage no definite information has as yet been obtained. There have been, however, reports of typhoid in towns near the river.

The most probable source of the epidemic seems to be Deferiet, both from the time of the outbreak and from the sewerage conditions. Two points, however, make pollution to a lesser extent, at least, from other places, seem probable. There was a considerable thaw and hard rains during the 20th, 21st and 24th of December. This may have washed infectious material into the river. There are also many mills, mainly engaged in the manufacture of paper and pulp, situated along the river. The privies in these mills are in nearly all cases located over the river. Light forms and convalescent cases of typhoid may have existed among the men at work in these mills, and who used these privies.

Deferiet, also using Black River water, may have obtained its fever from pollution from Carthage or other points above. Carthage likewise has a Black River water supply. This village has for years had much typhoid.

Prof. Landreth came to Watertown for the second time on Feb. 20, remaining three days, and making further investigations and recommendations to the local Board of Health. Under these recommendations, steps were taken toward the instruction of the people in the proper use of disinfectants and toward providing them for those unable to buy them. Steps of a similar nature were taken at points of possible pollution of the water from towns above. A thorough cleaning and the disinfection of all privies in the city was also recommended, and the work started.

The construction of a filtration plant was commenced last fall. The plant has been designed by Mr. Allen Hazen, Consulting Engineer, New York city. The completion of this plant is looked for some time during the summer. The work will be pushed as rapidly as possible.

The Watertown Chamber of Commerce, believing that the seriousness of the case warranted the entire attention of some sanitary expert, recommended that, if Prof. Landreth were unable to give his entire time and attention to the matter, someone else should be employed to do so. In accordance with this, the Board of Health—funds having been provided by the Common Council—have employed Geo. A. Soper, Ph. D. Dr. Soper arrived in Watertown on Feb. 25.

There has been no lack of harmony among the different city authorities. The best interests of the city have at all times been the only consideration.

It is but fair to state that the St. Regis Paper Co., the owners of the village of Deferiet, have been and are ready to do all in their power to stop the pollution of the river by their employees. And they have co-operated in establishing a system of inspection to insure the disinfection of discharges and to keep them out of the river.

That the worst of the epidemic has passed seems probable, at least as far as the primary infection is concerned. New cases, although common, are not being reported as frequently as during the first part of February. Many of the cases reported recently indicate a secondary infection. That the stringent measures being taken by the authorities at present will suppress this source of disease may be expected.*

*The following figures are given in the preliminary report of Prof. O. H. Landreth covering the prevalence of typhoid at Watertown in the past:

The city has in the past had more than its share of typhoid. The records in your office show the following deaths from typhoid during the preceding six years:

Year.	Deaths from typhoid fever.	Year.	Deaths from typhoid fever
1898.....	19	1901.....	8
1899.....	18	1902.....	15
1900.....	22	1903.....	17

The cases and deaths during each month of 1903 were as follows:

1903.	Typhoid Cases.	Typhoid Deaths.	1903.	Typhoid Cases.	Typhoid Deaths.
January ...	23	0	July.....	23	1
February..	42	2	August...	22	2
March	29	5	September	21	0
April	18	0	October...	14	0
May	3	3	November	7	1
June	9	2	December.	15	1
Total				226	17

AN EPIDEMIC OF TYPHOID FEVER IN EAST MINNEAPOLIS.

By Frederic H. Bass.†

The water supply of the City of Minneapolis is obtained entirely from the Mississippi River, unfiltered. It is supplied from three different pumping stations.

Stations No. 1 and No. 2 are just above the Falls of St. Anthony, in the heart of the city. No. 1 was the first one installed and contains six pumps of various kinds with a total rated capacity of 33,000,000 gallons per day. It is operated partly by water power. No. 2 contains one pump operated by water power and has a rated capacity of 10,000,000 gallons per day. No. 3 is about three miles up the river from the other two. It contains two Worthington pumps of a capacity of 12,000,000 gallons per day each. Stations No. 1 and No. 2 pump directly into the mains. Station No. 3 can pump directly into the mains or to the Columbia Heights Rerservoir, about 2½ miles distant on the east side of the river.

The river is crossed four times by water mains: at Station No. 3 by a 50-in. pipe; at 32d Ave. N. by a 24-in. pipe; at 20th Ave. N. by a 24-in. pipe, and at Central Ave. by a 16-in. pipe. The first three are submerged lines laid on the bottom of the river, the other crosses on the steel arch bridge which is the main commercial artery between the two parts of the city.

The 20th Ave. crossing has been out of commission for some years. In December a break occurred in the 32d Ave. crossing of a very serious nature, and it was thought best to repair the 20th Ave. crossing, which is now (Feb. 23) being done. The Central Ave. crossing had been shut off for the winter as trouble had been experienced in previous winters from freezing. The freezing was probably due to the fact that there was little flow in the pipe due to the equal pressures at each end.

For some time previous to the break just mentioned, practically all the water supply was from Station No. 3. When the break occurred, Station No. 2 was brought into service. (Dec. 30, 1903.)

Above Stations Nos. 1 and 2 empty several overflow sewers, also Bassetts Creek (into which empty 16 sewers), and all of the sewerage from Nicollet Island, which is a thickly settled residence and manufacturing district. From this island lead 36 sewer outfalls, about equally divided on the east and west sides. The lower shore of the island is also studded with outhouses.

Station No. 2 worked at a pressure of about 85 lbs. A 24-in. main leads out from it. The Reservoir is about 205 ft. above the pump in Station No. 2. From the 50-in. main connecting the reservoir with Station No. 3, leads one 12-in. and one 16-in. main. It seems probable that at times the water from Station No. 2 must reach as far north as Broadway. This point could have been determined by noting the pressures existing simultaneously at various points of the doubtful district, and it was the intention of the writer to do this if possible, but unfortunately for this object and fortunately for the people of the East Side, the closing down of the pumps of Station No. 2 took place too soon. (Feb. 18.) The stopping of these pumps was ordered by the water-works committee of the City Council in response to a request from a body of citizens called together by a special committee from the State University. It might be said here that the students of the University have not yet been affected to any great extent, although many of them live in the infected district.

The closing of Station No. 2 was followed by a reduction of pressure such that the residents in the most remote and also the most elevated section could not get water at all times of the day. It was to satisfy the demands of these people (who were very few in number) that Station No. 2 was started, and then when that source of supply was no longer available, the main across Central Ave. Bridge was opened and the voices of the people from the distant section were hushed. There appears to be no reason why this could not have been done in the first place except that the idea did not seem to present itself to the Supervisor of water-works.

As has been said, Station No. 2 was started Dec. 30, 1903. About a week later an unusual amount of typhoid fever commenced to appear on the East Side. The typhoid in 1903 had been normal for several months, 28* cases in Oct., 30* cases in Nov., and 35* cases in Dec. In January, 192* cases were reported, 60% on the East Side. The City Health Department was naturally aroused and soon learned of the pumping going on at Station No. 2. Immediate notice was given to the people of the East Side through the papers and through the sanitary inspectors of the Department of the dangers from the water, urging boiling of all drinking water.

It seemed very probable that there was some connection between the introduction of the water of Station No. 2 and the epidemic, though the City Water Department contended that the epidemic was due mostly to bad well water—it being known that there were many wells in the city supplying drinking water unfit for domestic use.

The investigation of the water has not been so thorough as would be desired on account of lack of time, but enough evidence seems to have been collected to show beyond doubt the partial cause (if not the source and almost total cause of the epidemic); namely, the water supplied from Station No. 2.

From a study of the typhoid death rate by months for the last twelve years and the use of water from Stations Nos. 1, 2 and 3, the writer has not been able to trace any marked connection between the use of water from the lower sta-

†Instructor in Civil Engineering, University of Minnesota, Minneapolis, Minn.

*It is estimated by the City Health Dept. that about 50% of all typhoid cases were reported. Of 12 deaths in January and February, only 2 had been previously reported as typhoid cases.

tions and increased typhoid fever rates. In the report of 1899 the City Health Commissioner states that typhoid tends to increase among users of well water after heavy rainfall and among users of city water after use of lower pumping stations. This time at least the connection appears to be very plain.

On the map the distribution of the cases is shown. In just the places where the water known to be contaminated by sewage from a source where typhoid was already present flowed, in just those places has the typhoid been the most prevalent.

Many times has the city of Minneapolis been warned, and as many times have the warnings been disregarded. On the East Side of the river, opposite Station No. 3, is a new station, the engines of which are now being started for the first time. With this station (No. 4) in addition to Station No. 3 in service, it seems as if the time when Minneapolis must use its own sewage for drinking and domestic use is at an end.

The Mississippi River above the city is subject to little contamination, and if the city discontinues Stations Nos. 1 and 2 and installs a proper filter plant as has been recommended by eminent engineers, it will have a water supply satisfactory from every point of view.

Chemical and bacteriological analyses of various water from the various sources mentioned are appended.

Chemical Analysis (parts per 100,000).

	City Health Board's standard for wells.	Well, 3 blocks N. of Central Ave.	Well cor. 3d Ave., N. E. and
Total solids	20. — 60.	110.0	.....
Chlorine	0.2 — 0.5	11.0	10.6
Free ammonia....	0.002 — 0.005	0.006	.044
Alb. ammonia.....	0.002 — 0.006	0.014	.014
Nitrites	None	Trace	High
Nitrates	None — 0.100	1.000	1.140

Bacteriological Analyses. (Bacteria per c. c.)

Station No. 3.	Reservoir.	Station No. 2.*
18 — 980	23 — 200	172 to 8,640

*Coli Communis are occasionally found in the water at Station No. 3. At the time of the epidemic here mentioned (Feb. 10, 1904) only 172 bacteria were found in the water at Station No. 2, but 85% of these were coli communis. This is probably due to the long continued cold weather and the presence of near-by pollution.

A PROPOSED SOLUTION OF THE BROOKLYN BRIDGE TERMINAL PROBLEM.

By S. S. Neff.*

In attempting to suggest remedies to relieve the crush at the Brooklyn Bridge terminals in Manhattan and Brooklyn, no attempt will be made to criticise the many proposed schemes or the present plan submitted by the Bridge Commissioner, which plan, no doubt, has considerable merit, but, like the majority of plans offered, means the expenditure of a large amount of money and too great a length of time to carry out. Immediate relief is what is needed, and in attempting to offer a simple solution applying wholly to elevated-train movement, I will do so without considering at present any change of the physical features of Park Row and Brooklyn terminals, except to the extent of a rearrangement of tracks and platforms as they now exist. This, with a rearrangement of train movement to be spoken of hereafter, should beyond a doubt give the relief which has been so long desired and which, in the writer's opinion, can be secured in a few months' time.

Fig. 1 shows the present tracks and platforms as they exist at the Park Row terminal. As is generally known, gauntlet tracks pass over the bridge in each direction, and are known as "red" and "white" tracks. Present operation allows bridge trains, or trains which simply run between the Park Row terminal and the Brooklyn terminal, access to both red and white line tracks at all hours of the day and night, while through trains are allowed to use red track during non-rush hours only, in which last case unloading is done on a platform between points marked I and J, whereas the loading is done from platform X Y. In the case of bridge trains running at all hours, and more especially rush hours in the forenoon, when no through trains are running, all passengers are unloaded on platform between I and J, and in the evening rush hours, when the bridge trains handle all the traffic, all loading is done on platform between points marked G and H.

Before referring to proposed change in tracks and platforms at this terminal, it might be well to consider the fact that the terminal, even in its present condition, can be made to handle the patrons of the elevated trains more satisfactorily. Bridge trains in rush hours, while they move at the closest safe headway, have only four cars in a train, whereas they should have five cars, and, if possible, six; if operated as six-car trains, 50% more people could be handled with the same train movement. At present the four-car trains are made up of one motor and three trailers, a locomotive unit system for movement at terminals prior to reaching the cable grips. As the bridge equipment is limited to 72 cars, 18 of which are motors, it is self-evident that with the present equipment the headway and number of cars in trains is fixed. If the bridge must continue to be operated wholly by bridge trains proper, and through trains are to be excluded, then, while this terminal can be very much improved at a small cost, why should not the trains be run at the same headway with six cars in a train with a multiple unit system of at least two motor cars, one on each end of the train. This would avoid a serious danger in the present system of operation in that bridge trains are now handled in one direction by backing the train over the bridge with the motor car and motorman on the rear end.

By reference to Fig. 1 it will be seen that in the morning rush hours all passengers are unloaded on a platform with 4,315 sq. ft. of passageway, and the same space is offered for the loading of all passengers during the afternoon rush hours. The island platform between X and Y, allotted to patrons for through trains, has but 3,840 sq. ft. of clear space. This platform is so narrow and so cut up by entrance stairways that great congestion occurs in the narrow space between stairways and edge of platform.

Fig. 2 shows a plan for an arrangement of tracks and platforms to give greater capacity for passengers and trains and to allow elevated through trains to use both red and white line tracks, to work in harmony with proposed change of tracks at the Brooklyn end of the bridge, which last-named change is most necessary to give a more prompt movement of trains and provide for storage tracks for relay trains.

The changes proposed at the Park Row terminal cover the following important points:

(1) The main building will not be interfered with except in floor system.

(2) The same system of tracks will simply be shifted.

(3) The proposed change of tracks will not interfere with any practical plans to the bridges No. 1 and No. 2 together, or the possible extension to the North River.

(4) For unloading rush in the forenoon hours, four platforms, with 19,803 sq. ft. of space, can be used; whereas now a space of 4,315 sq. ft. is used.

(5) For the afternoon loading rush hours, four loading platforms would be available, giving a total area of 19,803 sq. ft., whereas all passengers are loaded at present at one point on 4,315 sq. ft.

In commenting on the several points above mentioned, it is plain to see that relief can be obtained quickly and without any great outlay of money. The building itself should not be touched, except

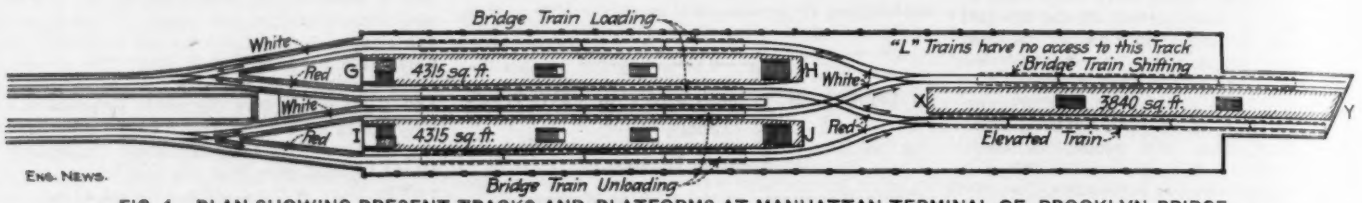


FIG. 1. PLAN SHOWING PRESENT TRACKS AND PLATFORMS AT MANHATTAN TERMINAL OF BROOKLYN BRIDGE.

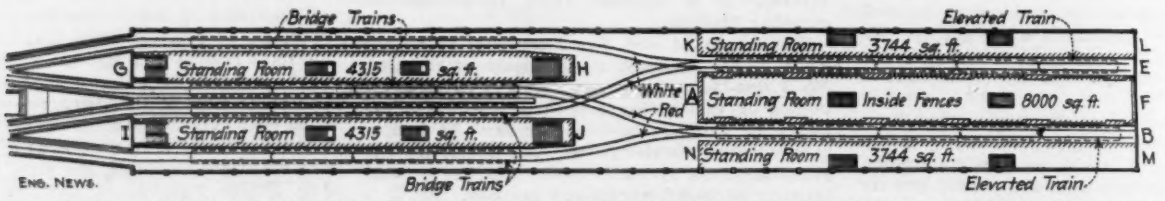


FIG. 2. PLAN SHOWING PROPOSED TRACKS AND PLATFORMS AT MANHATTAN TERMINAL OF BROOKLYN BRIDGE.

*Late Superintendent, Union Eelevated Loop Ry., Chicago, and Boston Elevated Ry., 13 East 29th St., New York City.

Bridge equipment is limited to 72 cars, 18 of which are motors, it is self-evident that with the present equipment the headway and number of cars in trains is fixed. If the bridge must continue to be operated wholly by bridge trains proper, and through trains are to be excluded, then, while this terminal can be very much improved at a small cost, why should not the trains be run at the same headway with six cars in a train with a multiple unit system of at least two motor cars, one on each end of the train. This would avoid a serious danger in the present system of operation in that bridge trains are now handled in one direction by backing the train over the bridge with the motor car and motorman on the rear end.

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(5) For the afternoon loading rush hours, four loading platforms would be available, giving a total area of 19,803 sq. ft., whereas all passengers are loaded at present at one point on 4,315 sq. ft.

In commenting on the several points above mentioned, it is plain to see that relief can be obtained quickly and without any great outlay of money. The building itself should not be touched, except that the longitudinal girders should be shifted and the tracks ending at E and B extended to hold a six-car train in each case. Additional storage space extending towards City Hall to accommodate one or more relay trains should be secured if it can be done without causing consequential damages. The plan as presented, showing but five cars in a train, will, to my mind, meet the present requirements, provided trains are operated on a proper system. In suggesting a possible extension of tracks beyond E and B, I am forcibly impressed by the need of storage capacity for relay trains at this most important terminal, and which, no doubt, will be fully provided for when bridges No. 1 and No. 2 are connected on Manhattan Island.

In the meantime I have suggested changes at the Brooklyn end of bridge to provide for relay trains shown by Figs. 3 and 4, which must work in harmony with proposed change shown on Fig. 2. As stated above, the proposed change of tracks will interfere in no way with any practical connection between bridges No. 1 and No. 2, and, in fact, after such a connection is made and a system of train movement looping over both bridges is inaugurated, if by chance troubles were to occur to interfere with such a loop movement, Park Row terminal as changed, Fig. 2, could always be used as a stub end terminal as at present.

As noted above, through trains move over the bridge at nonrush hours only, causing, as we have stated, the loading of all passengers on platform G H and the distribution of the multitude at the Brooklyn end of bridge, causing the use of steps and long passageways, being at times a puzzle to regular patrons to reach their proper train. I am correctly informed that at one time and for nearly a year through trains (electric) passed over the bridge at all hours, including rush hours. I have never been given any reason for their discon-

tinuance, but from an operative point of view long gaps must have occurred between trains, and there were no relay trains at hand with which to fill in the gaps. It can be readily seen that with the mass of humanity accumulating on one small platform, or in the entrances to it, this in itself was enough to condemn through movement, especially during outbound rush hours. There is, of course, a question as to the possible difference in safe operation of trains by electricity on close headway as compared to the cable movement. Without going into detail in this argument, I feel absolutely safe in denouncing the present operation of the bridge trains by cable and the use of the vacuum air brake.

In recommending the change of tracks and platforms at Park Row, I will analyze the movements which could be effected if such changes were made and all B. R. T. electrically-equipped trains moved over the bridge at all hours. In doing this it would be necessary to assume that all B. R. T. trains, as well as Long Island trains now running into Brooklyn terminal, would be moved by electricity, and that the safe headway between all trains during rush hours would be one minute, and that the cars in trains would number six; this would absolutely fix the number of passengers which could be handled per hour over the bridge tracks.

For inbound unloading rush movement in the forenoon hours, through trains will as at all hours use both red and white tracks, and will have, if necessary, platforms I J, N M and K L to unload on, and if needs be platform A F in addition, which, however, during all hours except afternoon rush would accommodate all outbound B. R. T. passengers. To facilitate train movement in forenoon rush, if a train were coming in on white line track and no train were on track E. the train would move up and unload on platform K L, otherwise on platform I J. For the same movement on red line track if track B were not occupied the train would move up and unload on platform N M. In both cases when stub tracks at E and B were occupied, unloading would take place at C and D on platform I J, and in both cases where the unloading took place on platforms K L and N M, one stop, namely, at C and D, would be avoided. The merits of the proposed train movement and change of platforms for unloading purposes are, of course, infinitesimal in value as compared to loading facilities. In both cases, of course, the undesirable change of cars and climbing staircases at the Brooklyn end of the bridge is dispensed with.

For loading purposes, we will have four separate and distinct loading platforms, namely, G H, K L, A F and N M.

Whether or not such a change as is proposed is put into effect, there will always be two rates of fare, namely, the 3-ct. bridge fare between Manhattan and Brooklyn and the 5-ct. fare between Manhattan and points on the B. R. T. system, other than the Brooklyn Bridge terminal, and in addition there might be the possible collection of a 10-ct. fare to points on the B. R. T. system where a double fare is demanded, the first fare being paid at Park Row, the second on the trains near the eastern terminals.

The general idea of having four loading platforms simplifies the situation, and in addition to giving four times the present loading space, separates the passengers for the different routes, and with the proper operation of trains insures safety and dispatch. It is self-evident that at least one platform of the four should be set aside for 3-ct. fares only, and that the traffic pulse should show exactly the number of trains and cars per hour needed to handle the 3-ct. fare passengers between Park Row and Brooklyn terminal, and that this movement should be minimized so as not to interfere with the through trains loading from the three remaining platforms.

By an actual passenger count the three platform spaces for 5-ct. fares could be arranged differently as to floor space in each, to apportion spaces for passengers using certain trains. As an example, platform N M could be assigned to Ridgewood trains; K L to East New York trains; platform A F could be subdivided and one half given to 5th Ave., Bay Ridge, Bath Beach and Coney Island, and the other half to Prospect Park, Manhattan Beach, Brighton Beach and Coney Island trains; this during the afternoon rush hours. To avoid the annoyance of the collection of a second fare on trains to Coney Island and the races (which movement as a rule does not occur during the evening rush hours), platform K L and N M could be used for this business, with a collection of 10 cts. before gaining access to the platforms.

In rush hours, with the proper sign displays and announcers on the lower deck, passengers could readily be separated and gain access to the platform from which their train was to leave.

To facilitate proper and safe loading of passengers, all platforms should be encased by an iron fence, with gates opposite all entrances to car

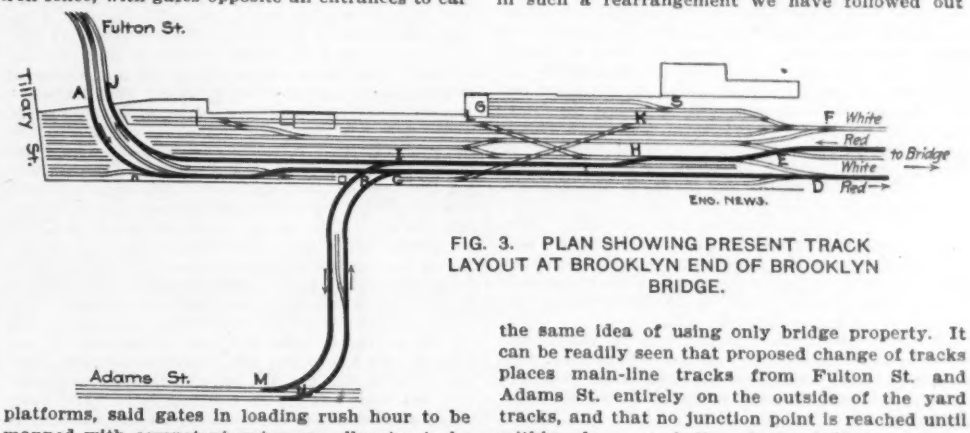


FIG. 3. PLAN SHOWING PRESENT TRACK LAYOUT AT BROOKLYN END OF BROOKLYN BRIDGE.

platforms, said gates in loading rush hour to be manned with competent gatemen; all gates to be operated by one head at point marked A, a point from which all trains could be seen and started.

As has been stated, successful operation of Park Row terminal will depend not only on additional track and platform facilities, but the ability to provide storage tracks for relay trains with which to fill in gaps and maintain a fixed minimum headway of trains. Reference is made to Fig. 3, which clearly shows the present track layout at the Brooklyn terminal of the Brooklyn Bridge. At a glance one can see that this terminal was arranged wholly for bridge trains running only between Brooklyn and Manhattan, causing a transfer to and from B. R. T. trains on the upper deck. The heavy black lines indicate present main line movement for B. R. T. trains from the

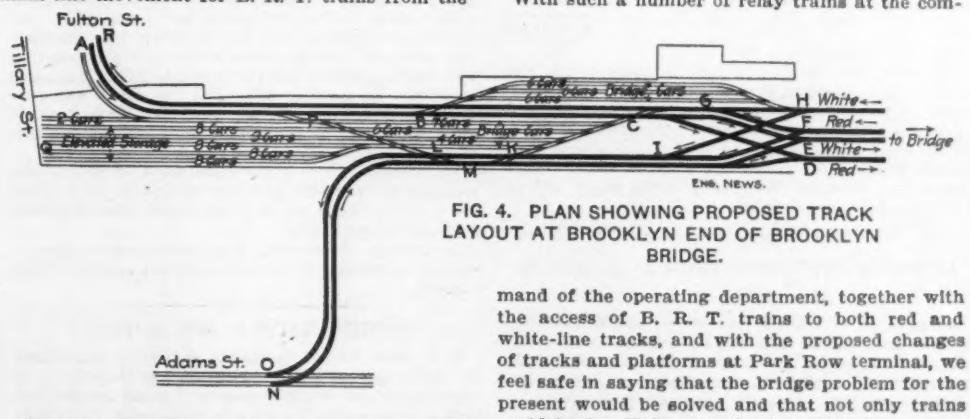


FIG. 4. PLAN SHOWING PROPOSED TRACK LAYOUT AT BROOKLYN END OF BROOKLYN BRIDGE.

Adams St. and Fulton St. lines. At the time these lines were connected it was no doubt considered the simplest and cheapest way in which to make the connections, but from an operative point of view the connections have outlived their usefulness.

First of all, the storage capacity of the yard tracks is limited to 69 cars. Second, the arrangement of connections to storage tracks is intended wholly for bridge trains, offering not one car of storage room for B. R. T. trains. Third, the arrangement of main-line tracks for B. R. T. trains gives access to and from the bridge only by red track; and, fourth, there is a congestion of trains at junctions N M and I B C on account of the distance between these junctions being too short to accommodate a five or six-car train between either junction. This blocks trains inbound from A to B, outbound E H I J to and from Fulton St., or for free movement of these trains on Fulton St., a corresponding block to inbound and outbound trains on Adams St., the last-named trains using loop tracks on upper deck at Brooklyn end of bridge.

Whether steam or electric trains are operated, there will, no doubt, always be needed a certain loop movement at this point to take care of traffic in rush hours, when a fixed headway and a number of cars per train has been reached in bridge operation. Fifth, it will be noticed that near the end of yard at Tillary St. seven tracks are disconnected and the space occupied by these tracks is entirely useless for storage purposes.

Fig. 4 shows the most practical rearrangement of yard tracks at the Brooklyn terminal of bridge; in such a rearrangement we have followed out the same idea of using only bridge property. It can be readily seen that proposed change of tracks places main-line tracks from Fulton St. and Adams St. entirely on the outside of the yard tracks, and that no junction point is reached until within close proximity of the bridge shed, at which point both routes are directly connected with both red and white-line tracks. The proposed plan allows us to utilize the dead space near Tillary St., and to secure standing room for 80 cars, whereas the present yard track will only accommodate 69 cars. Further, we are able to provide for sufficient bridge trains proper between the points P M and C, as well as the three tracks between B and H, the last of which named tracks have access to main line only at H, causing an adverse movement on white track in terminal. This we have counteracted by connecting at the opposite end at point marked B; and in addition, we can store at least ten five-car trains for elevated service at the Tillary St. end of yard.

With such a number of relay trains at the command of the operating department, together with the access of B. R. T. trains to both red and white-line tracks, and with the proposed changes of tracks and platforms at Park Row terminal, we feel safe in saying that the bridge problem for the present would be solved and that not only trains could be handled promptly, but that the patrons of the road could be comfortably handled and the stockholders of the elevated road see a marked difference in the cost of operating the bridge division, which cost for the years 1902 and 1903 was 128% of the gross earnings.

A FILTRATION PLANT FOR PITTSBURG, PA.

On Feb. 27 the report was presented of the Advisory Commission appointed to review the plans for a filtration system for the Pittsburg water supply, prepared under the direction of the Commissioner of Public Works some time ago. The Commission was made up of Messrs. Rudolph Hering; Col. A. M. Miller, Engineer in charge of the Washington filtration plant, now under construction, and John W. Hill, Engineer in charge of the Philadelphia filter plant.

The Commission's duty was to report as to the

proper method of filtration to be adopted, and the size of the plant necessary to supply the entire city with filtered water and the correctness of the estimates of cost submitted by the Director of Public Works.

The Commission recommended that the works should have a daily capacity of 108,000,000 gallons, sufficient to supply a population of 400,000. Slow sand filtration is recommended, and at the rate of 3,000,000 gallons per acre per day, with allowances for cleaning and reserves, 40 acres of filters would be required. The following is an extract from the report as printed in the Pittsburg "Leader":

We recommend slow sand filters, which, with due regard to the low winter temperature of Pittsburg and vicinity, should be covered and rendered as thoroughly as possible frost proof. And, as to "the size of plant necessary to supply the entire city of Pittsburg, including the South Side," after a careful inquiry into all the available information touching the present consumption of water and the consumption which will probably follow the introduction of filtered water and water meters, we believe that 40 filters, each one acre capacity, or the equivalent of this area in sand surface, to operate for the present at a rate of 3,000,000 gallons per acre per day of 24 hours, will be sufficient.

Considering the sedimentation basin, we believe this should be constructed with a capacity of 100,000,000 gallons, giving about one day's sedimentation before the water goes to the filters. The clear water basin has been given in our estimate a capacity of one-fourth the capacity of the filters, or 25,000,000 gallons.

All other details we have adopted from the plan of the bureau of filtration, believing that they will be found well adapted to the requirement of the work herein proposed.

Then comes the following "estimate of cost of works proposed:"

40 covered filters		$2,908,880
100,000,000 gallon capacity settling basin		450,000
25,000,000 gallon capacity clear water basin		392,500
Low service pumping station		151,866
Four 35,000,000 gallon capacity low service pumps		363,000
Sand washer pumps, sand washers, ejectors, etc		64,000
Electric lighting machinery		5,000
Electric light wiring		25,000
River crossing to Brilliant pumping station two 48-in. steel riveted pipes in concrete		267,373
Two 15,000,000 gallon capacity high duty engines		225,000
42-in. supply pipe from Highland reservoir No. 2 to South Side		536,305
		$5,389,524
Engineering and contingencies, 10%		538,952
		$5,928,476
Meters as per estimate department public works:		
Pittsburg, 40% of $765,000	$306,000	
South Side	102,000	
		408,000
Land as per official estimate		415,000
		$ 6,751,476

The report concludes with:

We think that, in time to have influence on the size of the filtration works recommended, it is hardly practicable in the city of Pittsburg to reduce the figures used in the preparation of our estimates. If the success in reducing water waste by the use of meters is greater than we now estimate, and preliminary filtration becomes more successfully developed, the service of the works will be further extended in the future.

AN EPIDEMIC OF TYPHOID FEVER AT LEADVILLE, COLO.*

An epidemic of typhoid fever broke out in Leadville between Dec. 20, 1903, and Jan. 10, 1904, which was very sudden in its onset. The total number of cases, so far reported, is 450; deaths, 23. Many cases, of course, have not been reported, as several cases of walking typhoid have not come under the care of physicians, consequently a careful estimate would make the number 500 cases. Most of these cases occurred between the dates above mentioned. After Jan. 20 few cases have occurred.

The fact that these cases made their appearance simultaneously led the physicians to believe that an epidemic was prevalent. But there was, however, opposition to the diagnosis of typhoid fever, which was made by a representative of the State Board of Health. Two autopsies were held on bodies that had died from the effects of the epidemic, and in one was found perforation of the bowel, through a typhoid ulcer, with general peritonitis; and in the other were found typhoid ulcers, with a large hemorrhage. Numerous Widals were made and all proved positive. There can be no question whatever as to the diagnosis.

As to the source of the infection, we might say the following: The first case of typhoid fever in Leadville in 1903 was in the month of August. This case came from Breckenridge and was taken to St. Vincent's Hospital. Another case occurred in the same hospital in September and October. This hospital is situated on some of the highest ground in Leadville, and the drainage occurs towards the center of the city. The sewage from the hoppers, sinks, etc., before emptying into the sewer in the street, runs through a settling tank, where heavy matter is allowed to settle, and the liquids pass off into the sewer. This tank is made of brick and mortar, not cemented inside or out, and, consequently, is not waterproof. The theory of the State Board of Health as to how Leadville got its epidemic is as follows: Stools, which were not disinfected from these first few typhoid cases in the hospital, reached the settling tank. From here seepage occurred downward towards the street until the water main was reached. Of course, seepage will follow the line of least resistance, and the line of least resistance would be along some pipe, sewer or water main. This brought the seepage from this cesspool, which was contaminated with typhoid fever, to the water main. On Dec. 5 the main was drained in the vicinity of this hospital. In fact, it is the custom of the water company to drain portions of their water mains almost weekly for the purpose of making repairs. As soon as the mains were drained, a vacuum (?—Ed.) occurred, and, consequently, the seepage would flow into any crack in the main with which it came into contact. When the water was in the main, the pressure would be so much greater inside the pipe than out that seepage could not occur. But when the main was drained the pressure would be reversed. In a town like Leadville, it is not an uncommon thing, owing to the mining that is going on in the town and its vicinity, for the water mains to become injured from the settling of the ground, resulting, of course, in more or less leakage. Therefore, it would be an easy matter for contaminated sewage to come in contact with one of these leaks, and for the sewage to enter the main at the time it was drained. We believe that this is what happened in Leadville, and in this way the water became contaminated. This was borne out by the following facts: The water supply of Leadville, before it reaches the city mains, is as pure as any water supply in the state of Colorado. Nothing but contaminated water could cause such a large number of cases of typhoid fever (milk, flies and vegetables being excluded), and consequently, as typhoid fever comes from typhoid contamination, such contamination occurred somewhere inside the city mains. In view of the fact that the mains were being drained for repairs; the stools from the first cases of typhoid fever were not disinfected; that they were allowed to flow into a settling tank that was not water proof, amounting to nothing more than a hole in the ground; and seepage could easily reach the water mains; that the greatest number of cases occurred in the district, lying below the hospital, which would receive this contaminated water, while other districts which did not receive it had but very few cases, all point to this method as being the one which contaminated the water supply.

Now, as to what was done in Leadville: In the first place, all of the cesspools were disinfected by using unslaked lime, besides disinfection of all the stools from patients was insisted upon, and we believe very thoroughly carried out. Sewage, before it left the city of Leadville, and before it flowed into the Arkansas River, was again disinfected by unslaked lime. The city, which was quite dirty, was ordered cleaned, and they have now 14 scavenger wagons at this work. There have been no new cases reported for the past two weeks.

The representatives of the State Board of Health who managed the Leadville epidemic of typhoid fever were: Dr. J. B. Davis and Dr. U. D. McDowell, former Medical Inspector of the Board.

Dr. William C. Mitchell, State Bacteriologist, made a sanitary inspection of the watersheds and analysis of the water.*

*An official report by C. E. Cooper, M. D., Secretary of the State Board of Health of Colorado; published in the Sanitary Bulletin of the Colorado State Board of Health for Jan. 31, 1904.

*A detailed report on this inspection, and on the opportunities for the infection of the water supply through seepage of cesspool and other polluting matter into the street water mains, was made by Dr. Mitchell to the City Council of Leadville, and was published in the Leadville "Evening Chronicle" for Feb. 3, 1904. The inspection of the drainage areas covered less than two days. Neither it nor inquiring among physicians gave any evidence of typhoid in the drainage areas for a long time, but some pollution of the water supply was apparent and much more was seen to be possible at any time. Inspection of a few dairies showed a bad sanitary condition, but no typhoid fever connected therewith. Between Oct. 15 and Dec. 15, 1903, sections of water mains were shut off eight times, for from one to twelve hours, in order to repair mains and hydrants.—Ed.

HOISTING WATER IN MINE SHAFTS.†

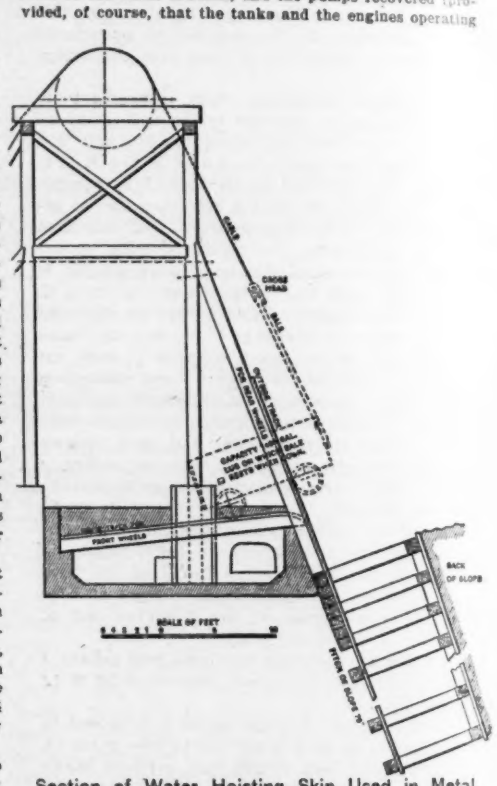
G. A. Burr, Parral, Chihuahua, Mexico: I regret that Mr. Norris did not give more attention to the hoisting of water in inclined shafts or slopes. It is my opinion that back and side-guides are not only unnecessary where rails are used as a track, but are unsafe, excepting in the case of a very firm hanging-wall, or roof and sides of vein-matter, having absolutely no tendency, either to settle from the back, or to squeeze from the sides, an effect which would inevitably force the guides out of alinement.

The accompanying illustration shows what I consider a better method of hoisting water than that described by Mr. Norris. This method is based on the general practice in metalliferous mines of the West, where skips are used on slopes; and, while it is not original with me, I have frequently used it with very satisfactory results for dumping both ore and water.

A special point to be observed is, that, as the slope approaches the vertical position, either the skip should be lengthened in order to have the center of gravity over the forward wheels, or the box should be depressed by raising the axles to its sides (instead of placing them underneath), in order to have the center of gravity over the rails, and thus avoid the danger of having the front wheels lift from the rails, which would result in derailing the skip.

I have been greatly interested in Mr. Norris' paper on account of my experience in hoisting water in metalliferous mines, where the usually limited shaft-area frequently precludes the hanging of a sufficient number of sinker-pumps to hoist the water.

The difficulty of solving this problem increases with the recession of the water-level from the place of water-discharge, and the consequent greater lift and increased duty required of the pumps. The use of tanks, or bailers, appears to me to afford a very practical solution of the problem, especially in cases where all of the pumps, including the "sinkers," have been drowned. Here the tanks can be swung into the hoisting-compartments, the level of the water lowered, and the pumps recovered (provided, of course, that the tanks and the engines operating



Section of Water Hoisting Skip Used in Metal Mines.

them are of sufficient capacity) without the inconvenience attending the tedious method of lowering steam and water-columns, length by length, or of breaking joints and lowering the pumps.

For this method of hoisting water, where steam is used, it is needless to say that quick, direct-acting hoists, in competent hands, possess great advantages over those of the geared type.

C. F. Heathcote, Beaconsfield, Tasmania: Mr. Norris has made out a very strong case for bailing-tanks versus steam-pumps under certain definite conditions, but under

Cost of Pumping 1,000 Cubic Feet of Water a Height of 1,000 Feet.

Name.	Speed.	Cubic feet of water.	Height of lift.	Cost of coal per ton. $0.50	Cost of coal per ton. $4.82
Short Mountain colliery (old)	Part	208,191	1,141	$0.3712	$1,4757
Short Mountain colliery (old)	Full	409,823	1,003	0.2920	1,3239
Short Mountain colliery (new)	Part	.....	1,200*	0.2250	0.6806*
Short Mountain colliery (new)	Full	500,000*	1,200*	0.1650	0.6200*
Hazleton shaft	Full	600,000	560	0.1674	0.6290
Fidler hoist		337,200	900	0.2400	1.0049
Wm. Penn hoist		280,000	727.8	0.2180	0.9820
Lytle hoist		500,000	740.6	0.2100	0.9749
Cornish plant	Part	372,940	687	0.2187	0.5647
Cornish plant	Full	571,390	687	0.1567	0.5020

*Calculated.

This plant has been in use at the Tasmania Gold mine, Beaconsfield, Tasmania, for 13 years, the average height of lift to which the figures relate being 687 ft., with 5% valve slip allowed. The total costs are made up as follows:

	Part speed	Full speed.
All wages, stores and repairs	$0.1787	$0.11663
Fuel	0.04003	0.04003

†Discussion of a paper by R. Van A. Norris, M. Am. Inst. M. E., Wilkesbarre, Pa., presented at the Albany Meeting of the American Institute of Mining Engineers and published in Engineering News of April 9, 1903.

those conditions only. The advantages of bailing from a drowned out mine cannot be disputed, for when this occurs, there is no output, and the usual winding-shafts and engines are always available; but for dealing with large quantities of water when shaft-sinking, it is out of the question. The economies shown by Mr. Norris are due less to the method of water-hoisting than to the substitution of one plant for six separate pumping stations in use at the Short Mountain colliery, and to the water-hoists being of ample power, while the pumps were often, apparently, fully loaded with no margin for overhaul and repairs.

For further comparison, the result of six months' work of a duplex, 24-in. plunger, Cornish plant, are given with those of Mr. Norris' in the accompanying table.

For anything below 1,000 ft., Cornish plants of this size become unwieldy and are out of the question, while it must be admitted by any one who has had experience with the timber trouble due to steam in mine workings, that with coal at $0.50 per ton in unlimited quantities, water-hoist expenses would, in the end, work out the cheapest. This trouble, however, does not occur with electric power.

The table also shows the great bearing that local conditions have (especially the cost of fuel) on the relative advantages of different plants. The coal-consumption is not given for the Hazelton plant, and calculated plant, and in the above table the costs are from the six months' run under adverse circumstances, calculated, of a Riedler plant delivering an average of 11,469 cu. ft. of water a day, a height of 600 ft. The coal consumption at $4.82 per ton of 2,000 lbs. having been $0.51415 per 1,000 cu. ft. of water raised 1,000 ft.

R. V. Norris, Wilkesbarre, Pa.: In regard to Mr. Burr's discussion, the hoisting of water on slopes in skips or tanks is quite usual as an emergency expedient in the anthracite region, but, as far as I know, the Hickory Ridge plant is the only one designed for permanent use; the guides which Mr. Burr criticises are only at the bottom where the tank strikes the water, and the roof and sides are absolutely solid, as he suggests they should be.

There was no intention, as Mr. Heathcote seems to infer, of prescribing water-hoisting as a panacea for mine water under any and all conditions, but an attempt was made to describe the practice as now in use, and to compare it with the ordinary pumping practice of the region.

Where fuel is very high, it unquestionably pays to consider it to the fullest extent, and under such conditions it might be advisable in water-hoisting to use multiple-expansion condensing engines, and, possibly where the water was good, a balance rope, instead of the simple direct-acting engines carrying steam nearly full stroke, which were described.

The 56,000,000 ft.-lbs. duty per 1,000 lbs. dry steam, to which Mr. Heathcote's Cornish plant seems to figure, appears rather high for a non-condensing plant, and leads me to assume that his pump is probably of the simple condensing type, while I should think that his high price of fuel would warrant a high duty pump of, perhaps, 120,000,000 ft.-lbs. duty.

In my opinion, except for the advantages noted on p. 21 of my paper, water-hoisting has no economical advantage over pumping at depths within the proper lift of one pump, its special sphere being in handling large volumes of water from considerable depths, especially where there is danger of flooding at certain seasons of the year.

RECTANGULAR ENGINE HOUSES.*

By Geo. P. Nichols.†

Nearly every engine house in this country is built on a circular plan, evidently for the reason that the design started with the turntable as the center. Why it should have retained this old form while nearly every other form of building has been modified to meet changed conditions it is not easy to understand; but probably because the turntable has been considered to be the only feasible method of directing the engine to its stall with the greatest economy of labor. The transfer table has been in use for years, but has not been used for this particular purpose. My object is to show the disadvantages of the roundhouse form, and to demonstrate the superiority of the square house.

In Fig. 1 is shown the ground plan of a recent roundhouse which covers the complete circle. In the center is the 75-ft. turntable; then a space of 90 ft. between the turntable and the inside wall of the house, all exposed to the weather. Each stall is provided with a double door of wooden construction, making 100 single doors. Under the conditions of engine-house service, several of these are left open at all times, making it difficult and expensive to heat the house properly. As the doors swing outward, if a snow storm occurs it is imperative that the snow be cleaned away and carried away, involving no small delay and expense, particularly in cleaning the turntable pit. Then did any one ever see a roundhouse of any size but what had several of the doors badly broken, requiring constant repairs? And how many more are badly fitted and stick when being opened. The stalls are narrow at the entrance and wide at the extreme end, the average desired width being at the center, involving an extravagant use of valuable space. The details of the engine pits need not be considered, as that feature alone remains unaffected, and in either case the pits can be built in accordance with modern practice, including as many drop pits as are desired.

When the equipment is sufficient to fill the roundhouse and the demand comes for additional motive power, it will be necessary to build another house and put in another turntable. There is then oftentimes the great disadvantage of not having sufficient available space, and a roundhouse of small capacity is but a poor affair, extravagant in requiring additional labor.

Fig. 1 shows also the plan of a 50-stall square engine house built. This consists of four walls, with the interior space covered by a roof of economical design. Through the center, longitudinally, from end to end, runs a 70-ft. transfer table, with 25 stalls on each side. The end of the stall begins at the end of the table, with no waste space; the pits are the same as in the roundhouse. The entrance is at the side, through one door. This can be of the steel roller type (which is not usual with the roundhouse on account of its great expense for a large number of doors); or it can be of wood, swinging in or sliding, as may be desired. These are not affected by snow. As the building is completely roofed over, work is not delayed by snow or rain; and it is evident what a difference there will be in the heating problem with one door, as against 50 doors. An engine enters the house, either under its own steam or, if dead, it is hauled onto the transfer table by the winding drum cable; then it is moved longitudinally and placed in the desired stall in the same manner—either by its own steam or the winding drum. As the table will have to travel only half the length of the house to reach the extreme end stalls, the speed of the table can be made nearly equal to the speed of the rotation of a roundhouse turntable, so no time is lost in this method.

As to the space occupied, the roundhouse requires about 50% more than the square form, and in the latter every available foot of ground is profitably used. Any number of additional engines can be provided for by simply lengthening the building and the transfer table pit.

For quick repairs, such as the recent shortage of motive power has imposed upon the mechanical department, there is nothing more economical than an electric traveling crane, and one or two stalls can be covered by a crane of moderate capacity, supplementary to the drop pit. The form of building construction reduces the cost of this equipment to a minimum. The conditions of light remain

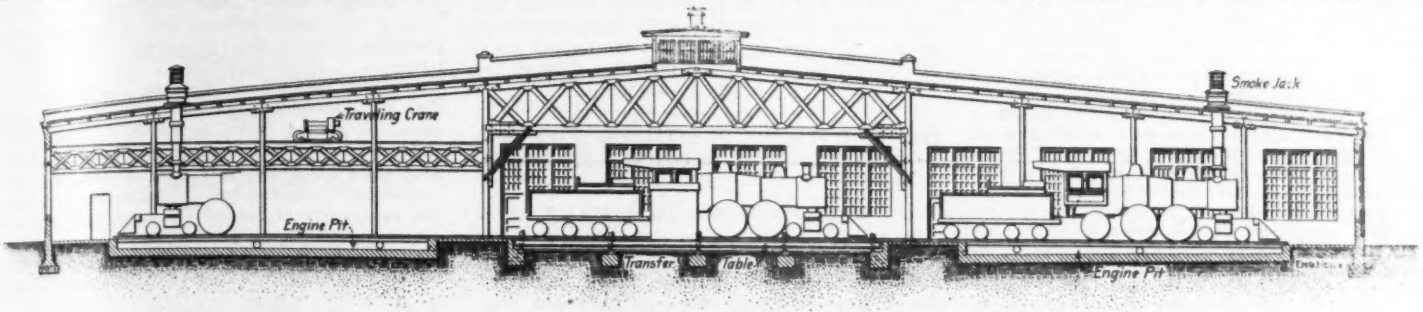


FIG. 2. CROSS-SECTION OF RECTANGULAR ENGINE HOUSE, WITH TRANSFER TABLE.
Geo. P. Nichols, Chicago, Designer.

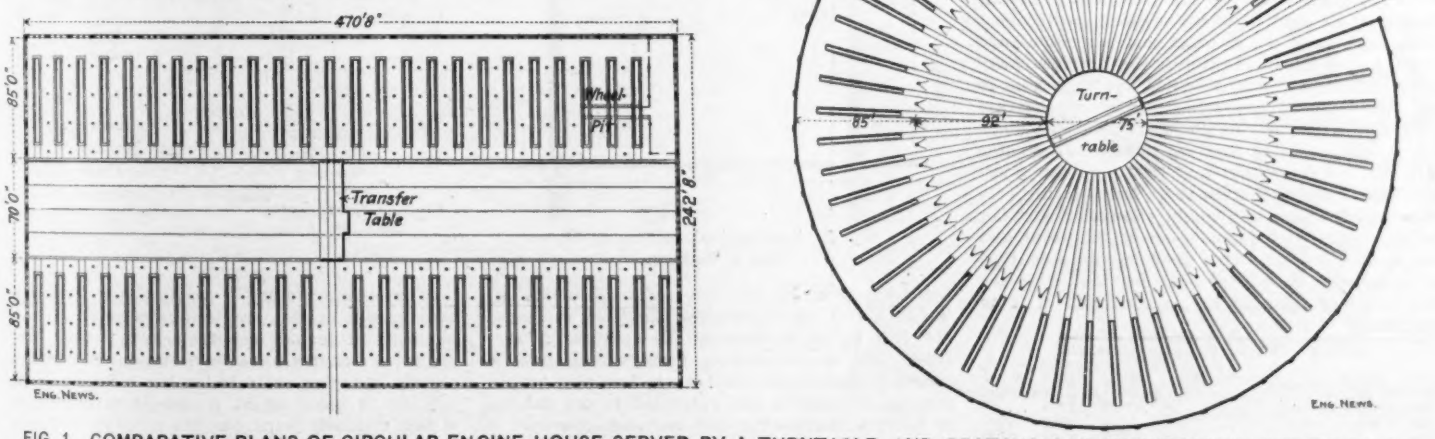


FIG. 1. COMPARATIVE PLANS OF CIRCULAR ENGINE HOUSE SERVED BY A TURNTABLE, AND RECTANGULAR ENGINE HOUSE SERVED BY A TRANSFER TABLE.

*Abstract of a paper read at the February meeting of the Western Railway Club, Chicago.

†Geo. P. Nichols & Bro., Engineers, 928 Monadnock Block, Chicago.

about the same, as the windows in the side walls and the lanterns in the roof should admit ample light. The smokejacks will remain the same.

You will naturally say this design leaves you without means of turning an engine, which is true, and a turntable must necessarily be provided at some convenient point outside of the house, unless the conditions will admit of the use of a "Y" or some other means. It would, however, be feasible to design the transfer table so that the frame will rotate on a traveling base, thus making it a combined transfer table and turntable, the only apparent objection being the increased depth of the pit necessary for such a device. You may also criticise the provision of a single entrance, and that placed in the center of the building, but the design is perfectly flexible in this direction, and one or more entrances can be provided wherever desired or the conditions require.

Regarding the reliability of the electric transfer table as compared with the turntable, after the experience of building a large number of transfer tables used in all parts of the country and under every conceivable condition, I have found it to be equally as reliable as the turntable. In fact, I have never known an electric transfer table, properly designed, to meet with any disabling mishap. As a matter of precaution, a hand attachment can be provided, which, however, I do not consider necessary. Should an extra precaution be deemed desirable, a second table can be provided to run in the same pit, which, of course, would increase the cost. The speed of a transfer table when loaded with a standard engine ready for the run, can be between 125 ft. and 250 ft. per minute, and with the high-speed gear thrown in for moving the table when empty, the speed can be at least doubled. One of the largest tables built runs at a speed of 800 ft. a minute when empty or with a light load.

The nearest approach to the style square form of engine house proposed in this paper is the arrangement recently adopted by the Terminal Railroad Association of St. Louis for handling all engines, near the entrance of the union station. In this case, three square engine houses with tracks running lengthwise through the three are provided, with a transfer table pit between each of the two houses, in which are two 75-ft., 150-ton electric transfer tables. As this is probably one of the busiest engine houses in the country, you will appreciate the confidence placed in the electric transfer table for reliable service.

THE COST OF CRUSHING QUARTZITE AT BARABOO, WIS.

By W. G. Kirchoffer, C. E.*

The municipal crushing plant at Baraboo, Wis., has been operated for another year in the same location to which it was moved in 1902. Attention was called to this change in the article published in Jan. 15, 1903, of this journal. A general description and the first costs of the plant were given in the article published March 27, 1902.

In the following table are given the comparative costs per cubic yard for the labor and materials used in the operation of the crusher for the past three years, and the average cost per cubic yard of crushed stone. In addition to the items that have hitherto been given, the writer has been able to give the cost of quarrying the stone separate from the crushing for the first time this year. It may also be noted that the total cost per cubic yard for the years 1901 and 1902 herewith given are slightly different from those listed in the previous articles, due to a minor change in working out the amount of depreciation of the plant and the repairs thereto. This year it was seen that the tools were so nearly worn out that their entire cost was included in place of 50% of it as heretofore.

Table of Cost of Crushing Quartzite.

Items.	Cost per yard for 1901.	1902.	1903.	Av'ge.
Stone in quarry	$0.04	$0.027	$0.0207	$0.0292
Labor quarrying stone	.....*	.....*	.3200	.....*
Labor crushing rock	.7140	.5354	.1980	.5891
Tools	.0560	.0215	.0148	.0308
Dies for crusher	.0677	.1069	.0636	.0794
Dynamite, caps and fuse	.0560	.1099	.0910	.0856
Rent of engine	.0854	.0661	.0635	.0717
Fuel for engine	.0744	.0468	.0477	.0563
Oil and waste	.0031	.0062	.0033	.0042
Hauling water and supplies	.....	.0282	.0499	.0395
Supplies	.....	.0113	.0137	.0125
Superintendent of crusher	.0685	.0615	.0476	.0592
Superintendent of quarry	.....§	.0771	.....‡	.....
Supt's horse and liveries	.0177	.0253	.....	.....
Depreciation, cost & reprs,%	.0871	.0692	.0736	.0766
Hauling stone to city	.5000	.5000	.5000	.5000
Totals	$1.7699	$1.6924	$1.5074	$1.6341

*Included with cost of crushing.
§Included with cost of superintendent of crusher.
‡Included with cost of quarrying.

Dividing up the various costs for the past season, we find that the cost of quarrying (labor, dynamite, tools, etc.) was $.4174 per cu. yd., and the cost of crushing was $.5193 per cu. yd., of which amount $.0345 per cu. yd. was for repairs to the crusher.

The output of the crusher for the past three years has been 1,920, 3,700 and 4,883 cubic yards, respectively. The crusher was run 46.8 days in 1901, 70 days in 1902, and 87.6 days in 1903, making an average output per day of 41, 53 and 55.6 cu. yds., respectively.

In 1901 the city saved $767.32, or about 40 cts. per yard by owning the municipal plant instead of buying the stone, as it had done in former years. On the same basis, $1,480 was saved in 1902 and $1,953 in 1903.

The cost of the macadam work done in this way, including the stone delivered upon the street, grading, spreading stone, claying and rolling, is a little less than 50 cts. per sq. yd.

While this plant is by no means a model one, and has not been operated in the most economical manner in every particular, yet the figures given here would go to show that this city, at least, has saved money by municipal ownership.

*Consulting Engineer, Baraboo, Wis.

THE "SLOT SYSTEM" OF ATTACHING SHAFT HANGERS AND FIXTURES TO CONCRETE-STEEL STRUCTURES.

By Henry Parsons Jones, M. E.*

While the use of concrete in combination with embedded steel rods or members, arranged according to various systems, is not a new departure, yet the impetus which, even during the past year, has been given to this form of construction for building and other purposes has been evidenced not only by an increase in the number of "systems" and of contracting firms which make a specialty of concrete-steel work, but also by the notable increase in space devoted to the subject in current engineering and technical journals, a large part of the literature being descriptive of work accomplished.

The Ingalls Building, at Cincinnati, already described in these columns (Eng. News, July 30, 1903), is a recent example, and while formerly there were in this country few instances of the application of concrete-steel to factory buildings, namely at the Pacific Coast Borax Co.'s plant at Bayonne, N. J., and the soap manufacturing plant of W. & H. Walker, at Herr's Island, Pittsburgh, there are to-day either wholly or partially completed a number of such examples, representing not only the most approved practice, but also, in certain instances, large and important undertakings. Among these may be mentioned the Bilgram plant, at Philadelphia, the plant of the Kelly & Jones Co., at Pittsburgh, the McDonald & Kiley shoe factory and the American Book Co.'s plant, both at Cincinnati, and the very extensive plant of the United Shoe Machinery Co., at Beverly, Mass.

Undoubtedly market conditions as represented by high prices of structural steel and greatly augmented productive capacity in the cement industry have been important factors in establishing, upon a firm foothold, concrete-steel construction. The introduction of the many types of concrete mixers and other appliances, together with increased knowledge of the material and facility in handling it, have also played an important part.

While approved systems of concrete-steel construction are amply capable of relying upon their intrinsic merits alone for an increase in popularity, it may be considered fortunate that circumstances are favoring rather than retarding a progress toward this most rational and permanent, and probably cheapest, form of perfectly fireproof construction.

It is true that recent investigations have shown that the deterioration of steel structures by corrosion is not so rapid as to promise imminent danger, but the fact remains that absence of deterioration depends largely upon the efficiency and frequency of application of protective coatings. The superiority of concrete—a material which not only requires no such protection, but which, on the contrary, increases in strength and durability with the lapse of time—seems to require no argument.

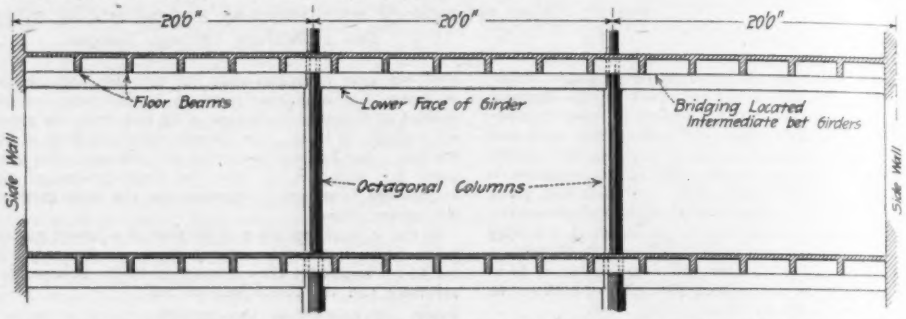


FIG. 1. CROSS-SECTION THROUGH TWO FLOORS OF TYPICAL CONCRETE-STEEL FACTORY BUILDING.

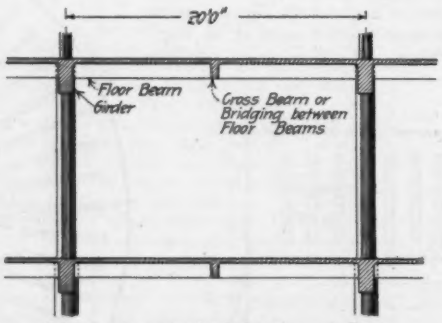


Fig. 2. Longitudinal Section of One Bay of Building.

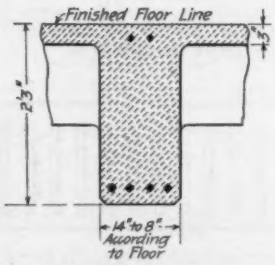


Fig. 3. Cross-Section of Floor Girder.

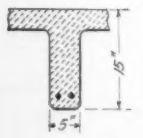


Fig. 4. Cross Section of Floor Beam.

In extending the use of concrete-steel to factory construction certain problems relating to the harmonizing of factory conditions with certain constructive features have been encountered, and in certain instances the solution has seemed so difficult as to bring about a change in design, or in fact seriously jeopardize the adoption of a concrete-steel building.

It may be assumed that the chief end to be attained in the design of any factory is such an arrangement and installation of equipment as will secure the greatest productive efficiency with the least expenditure. While the carefully designed building, through a betterment of physical conditions and environment, increases the efficiency of the plant, yet it may practically be considered as the mere "shell" of the enterprise, surrounding, as it does, the equipment or true source of production. It is therefore evident how necessary is a thorough appreciation, by the architect, of the requirements and point of view of the mill engineer.

During an association with the building committee of one of the above-mentioned plants, namely, that of the United Shoe Machinery Co., the writer

*574 Palisade Ave., Yonkers, N. Y.

had in hand the design of some method of attaching shaft hangers, stringers for countershafts, and other fixtures, to a concrete-steel floor system, and in order to convey a full understanding of the requirements to be met, it will be well briefly to state the general conditions.

The plant, which is designed according to the Ransome system, comprises two main buildings

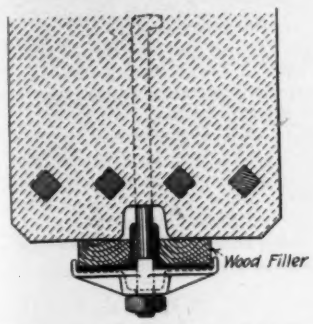


Fig. 5. Cross-Section of Angle Type of Slot, Showing Method of Anchoring to Girder.

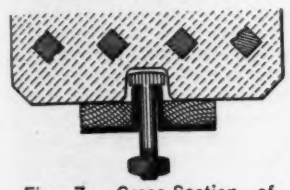


Fig. 7. Cross-Section of Angle Type of Slot, Showing Attaching Bolt.

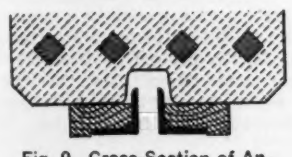


Fig. 9. Cross-Section of Angle Type of Slot; Wood Fillers Designed to Act as Shims Under Feet of Hangers.

resented by a card bearing a printed outline drawing, together with important dimensions and data, and also by a cardboard templet to same scale as floor plans, namely, ¼-in. per foot. By the use of these templets entire floor plans were laid out to the best advantage, due attention being given to clearances, light, belt lengths, etc.

While from the productive point of view the best arrangement of the various tools was thus effected, it naturally followed that the arrangement of driving shafts was not regular, to say nothing of countershafts, which, though kept in line as far as possible, required for their suspension a constantly varying arrangement of stringers.

The impossibility of pre-locating all driving shaft hangers, and stringers for countershafts, so as permanently to embed the necessary anchor bolts in the concrete, became at once evident;

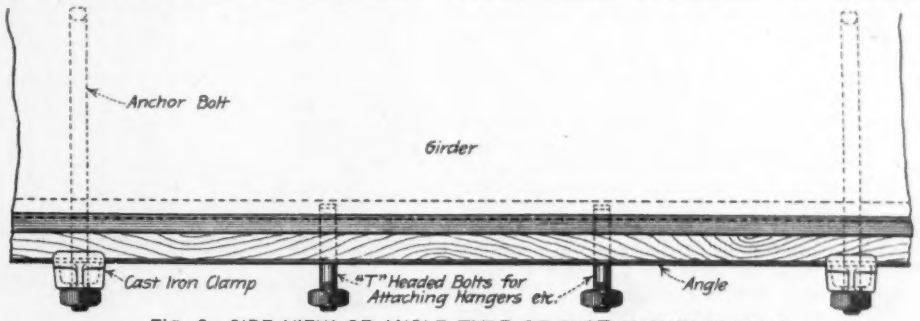


FIG. 6. SIDE VIEW OF ANGLE TYPE OF SLOT SHOWN IN FIG. 5.

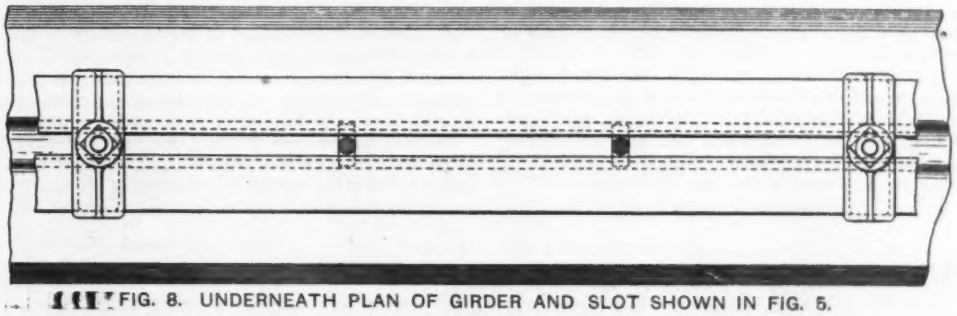


FIG. 8. UNDERNEATH PLAN OF GIRDER AND SLOT SHOWN IN FIG. 5.

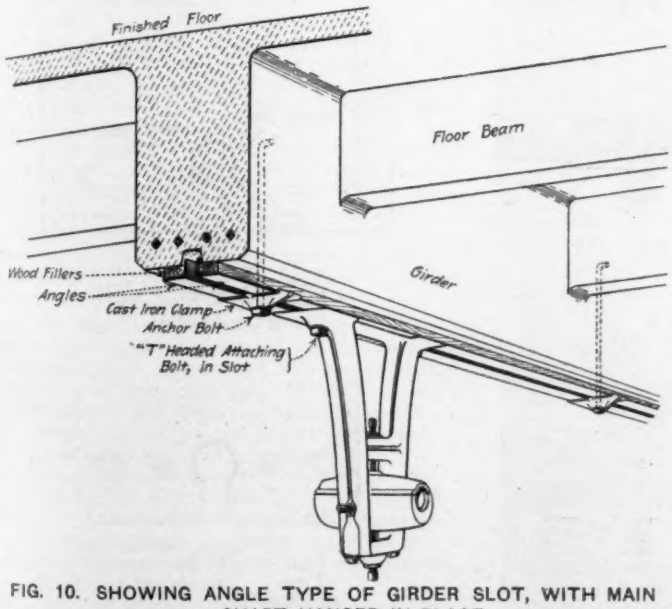


FIG. 10. SHOWING ANGLE TYPE OF GIRDER SLOT, WITH MAIN SHAFT HANGER IN PLACE.

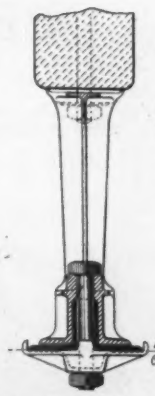


Fig. 11. Partial Section of Suspension Casting for an Intermediate Angle Slot.

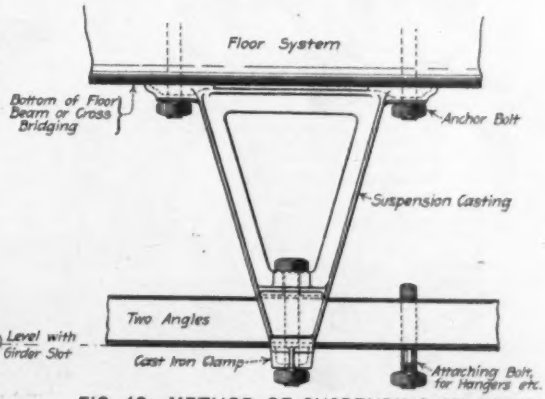


FIG. 12. METHOD OF SUSPENDING AN INTERMEDIATE ANGLE SLOT FROM FLOOR SYSTEM, BETWEEN GIRDERS.

each 520 ft. by 60 ft., four stories, one building 280 ft. by 60 ft., four stories, and several smaller buildings, all having a total of about ten acres of floor space.

Some two thousand machine tools were to be installed, all to be electrically driven by the "group system," that having been demonstrated to be the most efficient and economical for small tool equipment. As an indication of the thoroughness with which the committee had entered upon its work, it may be added that each tool was represented by a card bearing a printed outline drawing, together with important dimensions and data, and also by a cardboard templet to same scale as floor plans, namely, ¼-in. per foot. By the use of these templets entire floor plans were laid out to the best advantage, due attention being given to clearances, light, belt lengths, etc.

While from the productive point of view the best arrangement of the various tools was thus effected, it naturally followed that the arrangement of driving shafts was not regular, to say nothing of countershafts, which, though kept in line as far as possible, required for their suspension a constantly varying arrangement of stringers.

The impossibility of pre-locating all driving shaft hangers, and stringers for countershafts, so as permanently to embed the necessary anchor bolts in the concrete, became at once evident; moreover, a considerable part of the floor space was reserved for future growth and, therefore, neither could the locations of new tools be determined nor could changes in arrangement, though certain to occur, be provided for.

A thorough study of previous and current practice failed to discover any practicable method other than that of embedding anchor bolts for each hanger, or of suspending from anchor bolts a system of timbers to which hangers could be attached by bolts or lag screws as in ordinary mill work. In fact, one case came to knowledge in which the owners had, when confronted with the problem, substituted a timber floor in a concrete-steel building, rather than attempt some other solution of the difficulty.

Fig. 1 represents a cross-section of a typical concrete-steel factory building. Fig. 2 is a longitudinal section through one bay, and Figs. 3 and 4 are sections of floor girder and floor beam, respectively. To a structure of this approximate character, the mill engineer is required to attach shaft hangers and other fixtures.

Several designs were prepared with a view of suspending from the concrete floor system some arrangement of timbers which would afford all the lag screwing possibilities of mill construction; but not only were the disadvantages of exclusion of light, shrinkage, lack of headroom and of fireproof qualities apparent, but the estimated cost of material alone was excessive, to say nothing of the uncertain element of cost involved in overhead millwright labor.

The concrete girders of the floor system were evidently the members from which suspension of loads should be effected, and it suggested itself to the writer that if a slot could be formed along the bottoms of all girders which would permit the insertion at practically any point, of a "T"-headed or similarly shaped bolt, an "elastic" method of attachment would be provided throughout the entire plant.

It is unnecessary to discuss the various stages in the development of this idea of a "slot system" further than to say that many slot devices were considered, the aim being to utilize merchant shapes readily obtainable.

As it was inadvisable to suggest any radical departure either in the design of girder or method of

preparing the girder mold, the "angle" type of slot, shown in Figs. 5, 6, 7 and 8, was finally adopted, and, as progress of the work would not permit delay, the fact that steel angles of the required dimensions could quickly be obtained was also an important factor.

Along the center line of bottom board of girder mold extended a strip having a slight draft, thus forming along bottom of girder a shallow groove about 1½ ins. deep. Short ⅝-in. anchor bolts, spaced about 3 ft. apart, were embedded in girder along center line of groove, and two 2½-in. × 2-in. × 3-16-in. angles, with wood-filling pieces, were firmly attached to girder by light cast-iron clamps, as shown in section, Fig. 5. The space between vertical legs of angles was ⅞-in., allowing the insertion of a ¾-in. T-headed attaching bolt at any point, as shown in Fig. 7. To increase the anchorage the embedded bolts may either be bent at the upper end or they may be made of twisted or corrugated bars, upset and threaded at lower end. The depth of the cast-iron clamp is made the same as the thickness of the hanger foot, so that if position of hanger interferes, the clamp may be omitted, the hanger foot taking its place. If, on account of irregularities in castings, it is considered necessary to secure the effect of a wood shim under hanger foot, 2 × 2-in. angles may be used and the wood-filling pieces formed as shown in Fig. 9.

It seems quite probable that these wood-filling pieces will take up vibration and tend to keep nuts tight, as in case of a well-known type of rail joint. The long dimension of the T-head of the attaching bolt should be sufficient to prevent the bolt from turning while tightening the nut, or it may be slightly lipped to overhang the edges of the angles.

In Fig. 10 is shown the angle slot with hanger in place, and it is obvious that with groove molded in girder and anchor bolts embedded, the angle slot may be attached when and where required, the short projecting ends of unused anchor bolts being covered with a neat cap if desired.

In the buildings under consideration the floor girders were spaced 20 ft. c. to c., and it was therefore necessary to provide some means of suspending an intermediate shaft hanger, thus making the hanger spacing 10 ft. on centers. The method shown in Figs. 11 and 12 was finally adopted and consisted essentially of an intermediate angle slot suspended from light castings attached to the floor system by embedded anchor bolts. The spacing of these suspension castings will depend upon the size of the angles used, but about 6-ft. centers was found to be an economical arrangement. In any case the clamps for girder and intermediate slots should occur in line.

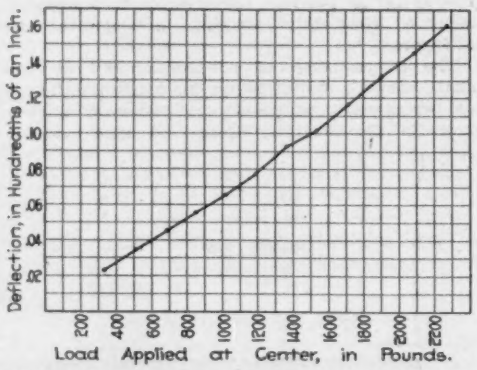


Fig. 13. Diagram of Deflection Tests of Angle Type of Slot, Shown in Figs. 5 and 7; Two 2½ × 2 × 3-16-in. Angles; 2-in. Leg Vertical; Anchor Bolts Spaced 3 ft. c. to c.

An attendant advantage of the intermediate slot is the economizing of countershaft stringers, tools frequently occurring in such position that it is necessary to run stringers from girder slot to intermediate slot only, instead of from girder to girder.

In ordinary practice the load upon an individual shaft hanger is comparatively light, in fact, it is liable to be considerably overestimated in considering the question of anchoring slot to girder. In order to determine the deflection of the angle type of girder slot, under various center loads, a series of actual tests were made, the results being shown in the diagram, Fig. 13. It will be observed that a center load of 1,000 lbs. produced a deflection of only about 1-16-in., while in actual practice hanger loads are probably not more than one-third that amount, and, moreover, the load is actually distributed through two hanger feet instead of being concentrated at one point.

The angle type of slot has its advantages, particularly that of being readily obtainable, but it is believed that certain other types are also worthy of consideration.

In Figs. 14 and 15 is shown a "pipe" slot, consisting of a 1½-in. standard weight pipe with a ⅞-in. slot, or a 1¼-in. pipe left open ⅞-in. before butt welding. Such a pipe may be permanently anchored in the girder during process of molding, its lower edges being slightly inside of girder face. The method of setting pipe in mold is shown in Fig. 16.

The resistance of the lips of the pipe counteracts the spreading action of the attaching bolt, which, being formed to fit the curve of pipe, is self-seating and cannot turn during tightening of nut. In regard to the possibility of spreading the pipe, it may be said that its resistance is considerable, the action of the bolt head is distributed along pipe and its edges, if materially spread, will come into contact with the hanger feet. As this type of slot does not project beyond the girder face, the loss of headroom is a minimum, there are no projecting anchor bolts, and, as no clamps are used, the entire length of slot is available for attachment.

In Figs. 17, 18 and 19 is shown a slot consisting of a pipe, as in Fig. 14, but attached to the girder by small clamps after the building is constructed, groove to fit pipe being molded along girder and anchor bolts embedded in the same manner as for angle slot. If it is desired to secure the effect of wood shims under hanger feet, the pipe may be arranged as in Fig. 20, with its edges slightly below girder face. Clamps with arms for carry-

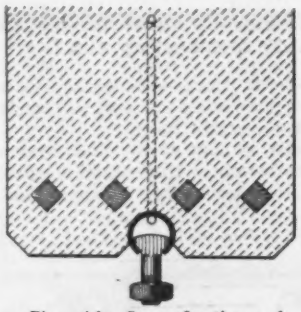


Fig. 14. Cross-Section of Pipe Form of Slot, Permanently Anchored Type, Showing Attaching Bolt.

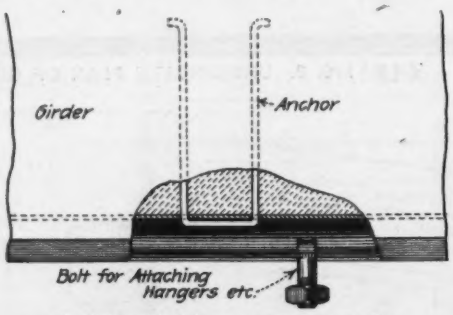


Fig. 15. Side View and Section of Pipe Form of Slot Shown in Fig. 14.

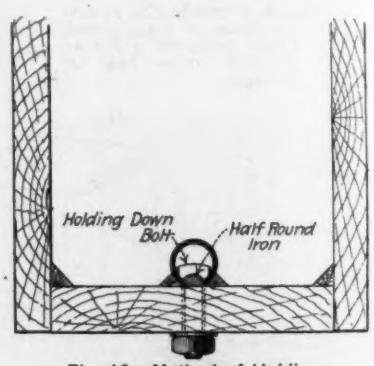


Fig. 16. Method of Holding Pipe Slot Shown in Figs. 14 and 15, in Girder Mold, During Construction.

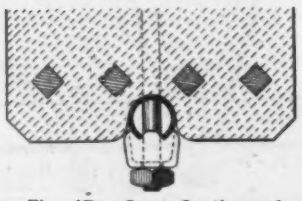


Fig. 17. Cross-Section of Pipe Form of Slot Anchored to Girder by Bolts.

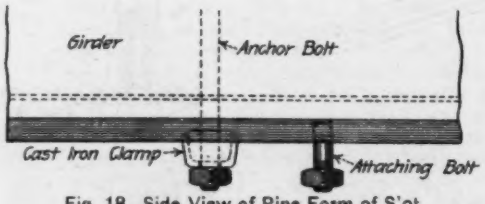


Fig. 18. Side View of Pipe Form of Slot Shown in Fig. 17.

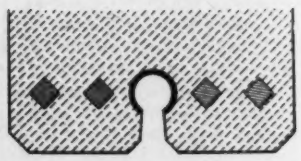


Fig. 21. Cross-Section of Pipe Form of Slot, Interior Type.

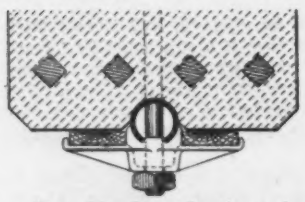


Fig. 20. Cross-Section of Pipe Form of Slot Designed for Shims Under Hanger Feet; At Points Where No Hangers Come, Takes Clamp Similar to That in Fig. 17.

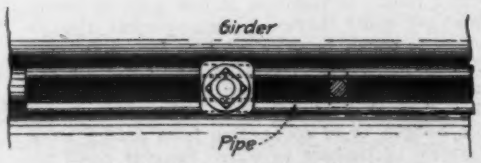


Fig. 19. Underneath Plan of Slot Shown in Fig. 17.

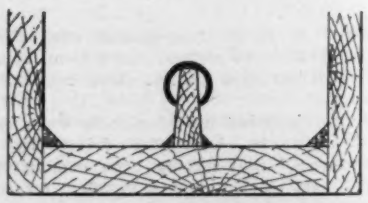


Fig. 22. Method of Holding Pipe Slot Shown in Fig. 21, in Girder Mold, During Construction.

ing shims as shown may be used each side of hanger and a simple clamp, without such arms, at other points.

It will be noted that the clamps shown in Figs. 17 and 20 are so designed as to aid in resisting the spreading of pipe, but it may be added that a tendency of the pipe to deflect under hanger loads is accompanied by a tendency of its edges to come together rather than separate. The pipe form of slot represents the greatest strength for least amount of material.

In Fig. 21 is shown what may perhaps be considered an extreme application of the slot principle, but the writer is not alone in his belief that such a design will be found practicable. It consists simply of an open pipe embedded within the girder, and it may or may not be considered to act as a tension member. The method of inserting pipe in mold is shown in Fig. 22, and while the construction of such a girder will probably not present difficulties, short experimental lengths having, in fact, been molded without trouble, the present state of the theory and practice of concrete-steel construction justly demands that departures from tried and established designs be made with care, therefore actual tests of a girder such as suggested will be necessary to the formation of an accurate opinion.

While the designs here submitted vary in constructive features, they are based upon the same fundamental principle and in common are capable of being adapted to the various "systems" of concrete-steel construction, including walls and columns and also "slab" floor construction, the buildings referred to having end bays built in that manner.

The advantages of an "elastic" method of attachment which can be once and for all provided for throughout an entire plant will be apparent, particularly to those who have had in hand the arrangement of tools and transmission in any factory. Speed of shafting naturally depends upon tool speeds and economical pulley sizes, and as the slot system locates the point of attachment at bottom of girder, the use of a hanger of the shortest possible drop to give necessary pulley clearance is permitted, resulting in decreased cost of hangers, which may be of any standard pattern and uniform throughout the plant.

The neatness of the device needs no comment, and the putting up and taking down of hangers is accomplished with the least amout of labor, leaving no bolt holes or other defacements to mar the appearance of the building.

Probably the most important feature is that of comparatively low cost. Timber of the size and quality suited for such purposes is in itself more expensive than steel, and on account of irregularities which will occur in anchor-bolt spacing, it is usually necessary in erecting such timber work to separately fit and bore each piece. On the other hand the accurate spacing of angle-slot anchor bolts is not important, and there is ample allowance for non-alinement of bolts along center of slot. The girder molds having once been provided with holes for the reception of anchor bolts, the same spacing prevails throughout the building, and all changes or preparation of varying templets obviated. No punching or other labor is required in preparing angles; castings are light and inexpensive, and require no machining. The labor of erecting the slot is a minimum, while in timber or mill construction the overhead millwright work is, as already noted, an uncertain and costly element. The absence of such timbering not only prevents the crowded appearance so often observed but it also decreases the fire risk.

In conclusion it may be said that the slot system, patent for which has been applied for by the writer and claims subsequently allowed, has, in competition with other devices, endured the very careful and thorough investigation of exceedingly competent engineers and been finally adopted for a plant containing some three miles of girders.

It is generally conceded that concrete-steel is the coming form of construction, and in thus bringing the slot system to the attention of engineers, it is believed that the use of concrete-steel for factory buildings may, perhaps, be further promoted by overcoming what has heretofore been a serious objection from the standpoint of the mill engineer, namely, the difficulty in providing for the attachment of necessary fixtures.

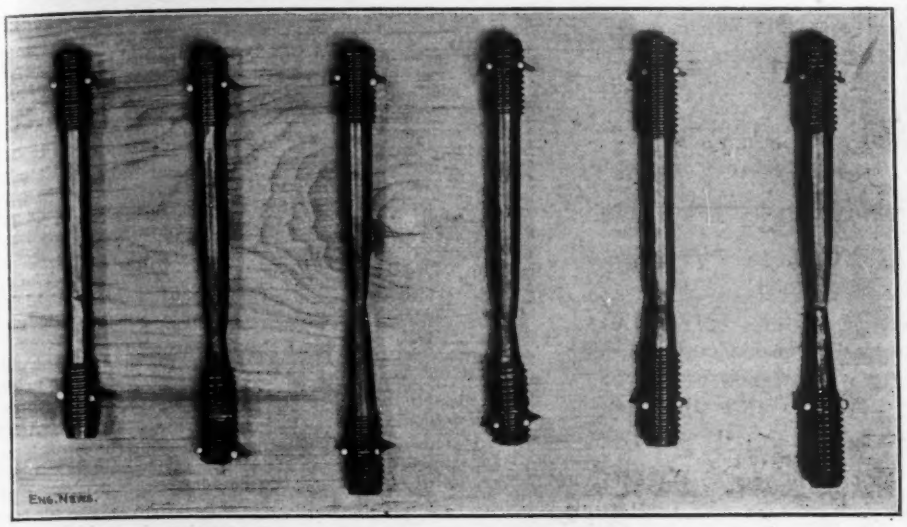


FIG. 1. SPECIMENS FROM HIGH-TEMPERATURE TESTS OF BRONZES.

METHODS AND RESULTS OF SHOP-TESTING OF STEAM TURBINES.

By J. R. Bibbins,* Assoc. Am. Inst. E. E.

The ultimate satisfaction of the purchaser of any machine of novel character is determined almost entirely by his knowledge of its actual performance under service conditions. Thorough testing of the product of a machine-building works is important for this reason; it has the further advantage that it gives the builder valuable detailed information about the characteristics of his product.

This has been recognized by the Westinghouse Machine Co., ever since the establishment of its business in 1880, and in consequence its practice has been. not to conduct tests at odd intervals when it might be desired to determine the characteristics of a particular batch of material or the performance of a sample machine from a large consignment, but to subject every finished engine to a complete series of tests before shipment. The data of these tests are filed in the record books of the company and are available at all times to customers.

When the company took up the manufacture of the steam turbine a few years ago, the same method of thorough testing was applied to this engine as had been found so advantageous in the case of reciprocating engines. Further, by reason of the uncertainty and incredulity regarding actual turbine performance which at first prevailed, it became an evident necessity to eliminate all experimenting at the purchaser's expense, and to provide a testing department at the works, of sufficient capacity to accommodate machines of all sizes. A complete testing equipment of this character has accordingly been installed, and nearly 1,000 independent tests upon steam turbines of various capacities have been carried out up to the present time.

MATERIAL TESTS.—A knowledge of the quality of the material that goes into a machine is essential to a correct judgment of its value. Material testing is fully provided for in the testing equipment under consideration. The order of tests upon materials and product in general follows the latter through its various stages of manufacture. At the outset are determined the physical and chemical characteristics of the va-

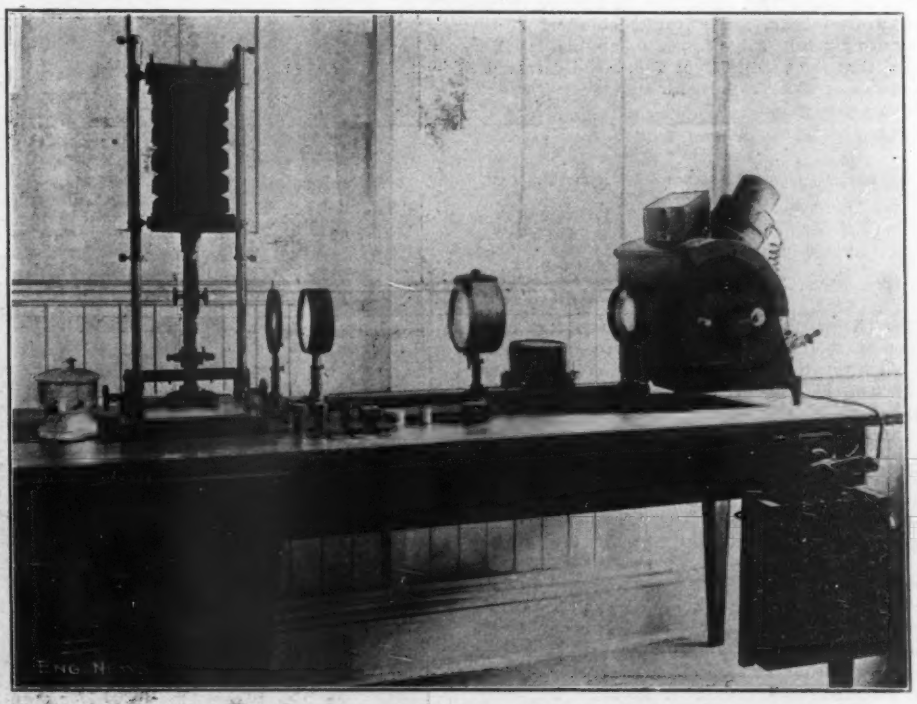


FIG. 2. APPARATUS FOR MICROPHOTOGRAPHIC ANALYSIS.

*Westinghouse Machine Co., East Pittsburg, Pa.

rious metals used. Samples of pig-iron, forgings, castings, brasses, bronzes and anti-friction metals are obtained from each heat or batch, and subjected to physical, chemical and microscopical tests to determine the suitability of the various metals to the work for which they are particularly intended.

Specimens from the forge and cupola are subjected to tension, compression and bending tests, in testing machines of standard make and large capacity. Where the future use of the material requires, tests are made at other than normal temperature. For example, the vanes of the turbine wheels, made of a special bronze alloy, are exposed to hot steam, which may be highly superheated; it is therefore important to know the strength of the vanes at high temperatures. The test specimens are heated while in the testing machine, either by a small electric furnace or by a molten-lead bath. Some results obtained in this way are given in Table I., accompanying. It will be noted that the conditions of Test No. 4 correspond to steam of 250 lbs. pressure superheated 420° F. above saturation.

TABLE I.—High-Temperature Tension Tests of Special Bronze.

Test.	Average ult. tensile strength, per sq. in.	Average elongation,	Remarks.
No. 1.	80,480 lbs.	22%	Tested cold.
" 2.	76,000 "	29%	Heated 320° C. 25 times —air cooled.
" 3.	76,000 "	26.5%	Heated 320° C., once—air cooled.
" 4.	75,280 "	30%	Heated to 440° C. = 824° F.; air cooled.

The photograph, Fig. 1, shows some test specimens of this material after fracture, tested at high temperature; the material is similar to that used in turbine buckets.

In the chemical laboratory quantitative analyses are made of all raw materials, the results furnishing an effective check upon the mechanical tests and the homogeneity of material.

The third method of analysis, involving microphotographic records of both new and finished material, gives exact knowledge of the change in structure under different conditions of temperature and stress. The apparatus employed for the microphotographic analysis is shown in Fig. 2. It consists of an electric arc lamp, the rays of which are projected and concentrated by means of special lenses upon the polished and etched surface of a metallic specimen placed directly under the objective of a powerful microscope. A glass receptacle with parallel sides, filled with cooling water, is interposed between lamp and instrument to absorb injurious heat rays. A camera is mounted vertically upon the microscope, a special eye-piece being used for obtaining the proper focus upon the negative. The specimens are prepared in small cubes if convenient. In some cases a chip or irregular fragment only may be available, in which case it is imbedded in paraffine. The specimens are then surfaced, highly polished upon one side, and etched with acid in order to bring out in relief one of the constituents of the metal or alloy.

The information thus obtained is recorded in the manner illustrated in Fig. 3, which shows a specimen record card of a steel forging for turbine shafts. The entire history of the material is here made available. These cards are kept on file for future reference.

WORKMANSHIP.—In all cases careful inspection and gaging of machine parts is required to insure accurate fits and clearances. The work is systematized by the employment of gages standardized in a special Pratt & Whitney measuring machine fitted with every refinement of micrometer adjustment and microscope reading attachments.

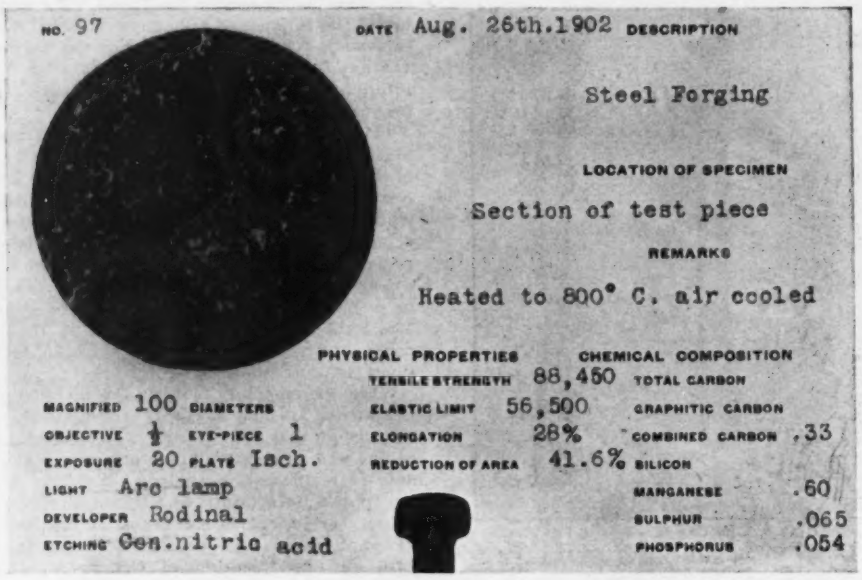


FIG. 3. SPECIMEN RECORD CARD OF MATERIAL TESTS.

In the first machining of the rotating parts of the turbine, it is found practically impossible to secure the perfect running balance that is necessary to insure freedom from vibration. A special instrument has been devised which has proven invaluable in detecting minute unbalancing in the various annular sections comprising the rotor which could not be detected by the usual method of rolling the section upon parallel knife edges to detect the heavier side. When all sections are balanced, transverse force moments upon any part of the shaft are entirely avoided. The instrument used for small work is shown in Fig. 4; a larger instrument installed over a pit in the turbine shop is used for heavier sections.

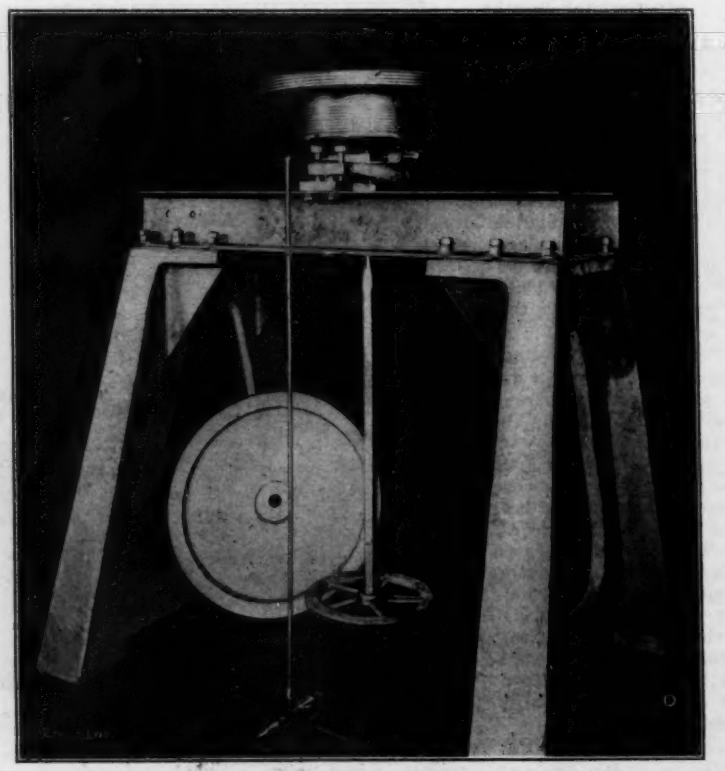


FIG. 4. BALANCE FOR WHEEL SECTIONS.

The instrument consists of a surfaced turntable held in an approximately horizontal position by a vertical counterweighted rod provided with an index at its lower end. This turntable is pivoted upon a beam supported by two knife edges, the beam being fitted with a traverse adjustment for the displacement of the turntable at right angles to the line of the knife-edges.

The disk as shown in position is first centered approximately over the knife edges, and the elevation of the counterweights adjusted so as to bring the center of gravity just below the knife edges. The displacement of the beam index is then noted, and the turntable rotated through 180 degrees. The displacement in the reverse position indicates twice the amount of unbalancing, also the approximate location of the excess metal. The sensitiveness of the balance may be made as high as .00002, or .002% of the weight of the section under test.

TURBINE TESTING FLOOR.—The concluding tests of the series are those upon the finished product; they are conducted upon the permanent testing floor which constitutes an important feature of the turbine building. The new machine is here tried out for workmanship and running adjustments, and finally subjected to official performance tests.

The testing floor occupies about 11,000 sq. ft. in the center of the turbine erecting building. Two complete outfits are provided, one for the testing of the smaller units and the other for larger units up to 3,000 KW. The outline drawing, Fig 5, shows the general arrangement of foundations, sump well and machinery. With the exception of the condensers and dry air pump all auxiliary machinery, piping, weighing tanks, etc., are contained in a capacious concrete floored basement. The sump communicates through a brick tunnel with a creek flowing past the building where a concrete weir and wing wall has been constructed. The test foundations shown are covered with cast-iron bed plates provided with T-slots.

It is seldom that a vacuum of over 29-30 absolute is obtainable in a power plant under working conditions. A condensing equipment has, however, been installed that will produce this result. For the smaller machines a 1,500-sq. ft. and for the larger ones a 3,000-sq. ft. Alberger surface condenser is used, with interconnected piping for relay operation. The "dry" air pump, located on the main floor, serves to remove the entrained air and vapor collecting in the upper part of the condenser, while the "wet" pumps withdraw solid water from the hot wells and discharge it into the weighing tanks. Only with this separation of the two functions of the condenser air pump can the best results be secured.

The main circulating pump is of the centrifugal pattern driven by a 50-HP. Standard engine. It is relayed by a duplex pump of similar capacity and may supply either or both condensers. Circulating water is drawn out of the sump well and discharged into the creek. The exhaust piping

enters the condensers at the hot well, each exhaust main being valved so that either condenser may be employed upon either group of machines to be tested. An automatic relief valve also communicates with each main to prevent accidental back pressure. During tests under normal vac-

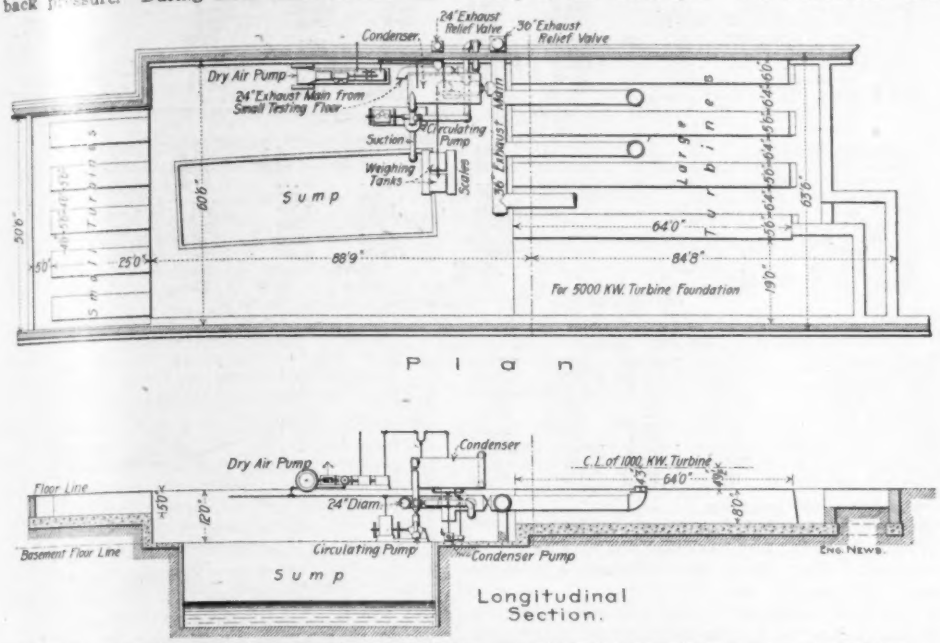


FIG. 5. OUTLINE DRAWING OF ARRANGEMENT OF TURBINE-TESTING FLOOR, SHOWING CONDENSING OUTFIT FOR LARGE TURBINES.

uum, the idle exhaust outlets are closed with blank flanges, but when the highest vacuum is desired all idle piping is cut out of service by auxiliary blanks applied in the interior of the 36-in. main and held in position against an annular projection by the interior pressure. Thus the slight leaks inappreciable on a 26-in. vacuum, but troublesome with 29 ins., are to a large extent avoided.

Steam for testing purposes is obtained from a plant of Babcock & Wilcox water-tube boilers supplying the entire shop. A large vertical separator at the turbine insures dry steam for tests requiring saturated steam only. When superheated steam is desired, the steam from the separator is deflected by valves into a gas-fired superheater contained in a small addition to the turbine building. The steam piping is by-passed at the superheater in such manner that saturated or superheated steam may at any time be furnished to either or both testing floors. With this apparatus any degree of superheat up to 400° F. may be obtained.

In all measurements a standard outfit of gages, thermometers, meters and weighing appliances is employed, whose accuracy is verified from time to time by comparison with registered laboratory standards. Observations are taken at regular intervals, practically in accordance with A. S. M. E. rules for steam engine tests. The steam or water rate is determined by weighing the condensation from the surface condenser in two steel weighing tanks, resting upon a standard scales.

Load tests are ordinarily conducted with a special form of absorption brake; or, on occasion, with generator and water rheostat. The former furnishes results independent of the generator. By reason of the high speed a specially designed water brake is used, shown in the photograph, Fig. 6, which enables accurate adjustment of the load upon the turbine to be made. In principle it consists of a disk, revolving freely within a casing, to the interior of which water may be admitted in controllable quantities. The water is forced to the periphery by centrifugal action, and superficial friction of the water upon the rapidly moving surface of the disk, furnishes the desired load. The drag or torque upon the shaft is directly proportional to the area of the submerged surface of the disk, and is measured by a lever attached to the casing, as in the ordinary brake

Electrical load is obtained without transformation to low voltages by an adjustable water rheostat contained in an addition to the turbine building. It is built in three independent sections, one section for each phase on three-phase power measurements. Variation in load is obtained by varying the distance between plates and the constituency of the electrolyte. The conductors and tanks are mounted upon high tension insulators, and potentials as high as 5,000 volts may be used directly from the generator without using step-down transformers.

SOME TEST RESULTS.—Some test results obtained with this equipment may be of interest.

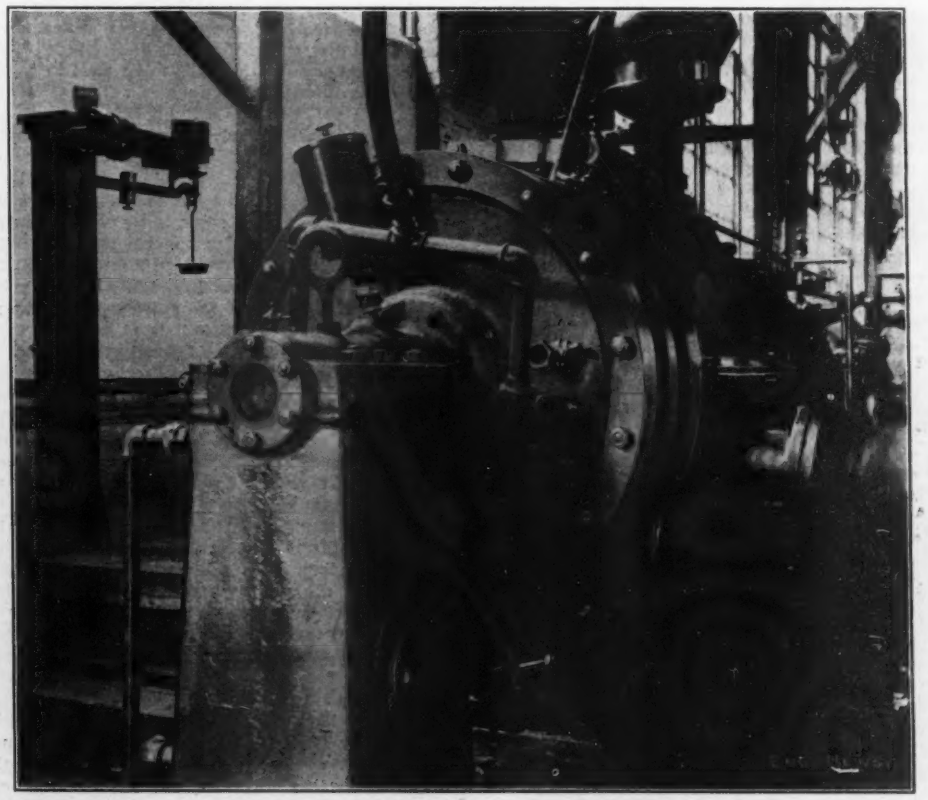


FIG. 6. WATER-FRICTION ABSORPTION BRAKE SHOWN COUPLED TO TURBINE.

Fig. 7 shows the general characteristics of a Westinghouse-Parsons turbine, a 400-KW. machine. It will be observed that the curve of total water consumption, frequently called the "Willans Line" in steam engine practice, is practically a straight line. This indicates that the steam turbine uses steam with the same thermo dynamic efficiency at all loads. The economy curve of the turbine (running condensing) is remarkably flat, the consumption at half load being only 8.7% higher than that at full load. The curve does not, in fact, begin to rise abruptly until one-eighth load is reached, which explains the ability of the turbine to show unprecedented "all-day" economy under loads fluctuating between wide limits, either gradually or suddenly.

The economy secured under favorable conditions is very high. The minimum of the curve of Fig. 7 is about 13.55 lbs. steam per electrical horsepower per hour, an economy that has probably never been surpassed in units of such small size. Table II. is a record of the results of the tests on this machine, both with saturated and with superheated steam.

On all turbines of this type a "secondary" valve is employed to secure heavy overloaded capacity. This valve admits high pressure steam from the first to the second expansion stage, resulting in a slightly lower economy on overloads. In the test graphically shown in Fig. 8, this valve was automatically opened in proportion to the overload just sufficient to maintain the proper speed. The resulting curve of steam consumption thus resembles that of a reciprocating engine with the difference, however, that in the engine the steam consumption increases with the load from about ¾-load, while in the turbine the full load steam consumption is maintained or even decreased, until 25% overload is reached, when the secondary valve becomes operative. In the case of the turbine tested this valve enabled an overload of 92% to be maintained.

Results upon a 1,000-KW. turbine, under moderate superheat and vacuum, are shown in Fig. 9 and Table III. The speed regulation curve is also shown. With a larger unit, 1,500 KW. in capacity (Fig. 10 and Table IV.), still better economy is attained—12.66 lbs. per E. HP.-hour at full load, equivalent to 10.75 lbs. per I. HP.-hour at 85% combined efficiency of engine and generator.

The advantage of superheat is clearly indicated by the curves in Fig. 10, which show an increase of nearly 14% at full load. Other tests upon this machine with high and with low vacuum show an increase in economy due to 1 in. additional vacuum of approximately ½ lb. per E. HP. at full load, 1 lb. at half load, and 2.3 lbs. at one-sixth load. These tests, were, however, made with saturated and not superheated steam.

SAFETY DEVICES FOR HYDRAULIC PLANTS.

By Frank B. Kleinhans,* M. Am. Soc. M. E.

There is always more or less danger in connection with the use of high pressures. The danger may be either to the operators or to the machine or plant. With hydraulic pressures the danger to life is comparatively small; indeed, it is possible for the cylinder of a hydraulic hoist to burst under full pressure and yet no injury be done to a person standing next to the cylinder. The reason for this is that although there is a high pressure, water is unlike steam or compressed air in that it does not expand when the pressure is released. If the cylinder bursts, therefore, the particles of the cylinder do not fly. For this reason there is little danger to life due to flying pieces of broken machinery in connection with the hudraulic plant. The danger is rather to the machine or other parts of the plant.

Suppose a plant is designed for a working pressure of 1,500 lbs. per sq. in., and consists of riveting machines, flanging presses, etc., and that the

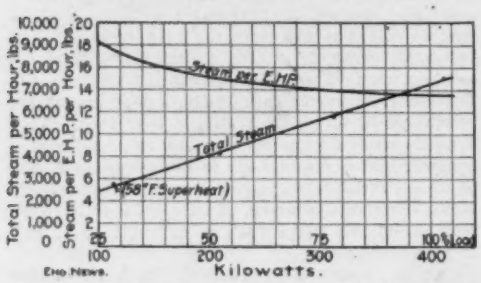


Fig. 7. Performance Curves of 400-KW. Steam Turbine.

Boiler pressure ..... 150 lbs.
Superheat ..... 100° F.
Vacuum ..... 28 ins.

main flanging press is fitted up with internal clamping cylinder and overhead cylinder. It is possible, under certain conditions, to operate the valves of certain machines in such a manner that the piston of one will push against another and thus we will get an intensified pressure in the cylinders which have the smaller capacity.

As these machines are designed for a pressure of 1,500 lbs. per sq. in., this intensified pressure produces an abnormal stress in the material. We are thus apt to have broken pipes and cylinders as the result. This can be avoided by placing relief valves in the pipes leading to each one of the cylinders, which are subject to the intensified pressure. Of course, if the capacity of the main cylinder is greater than that of all the other cylinders which it would be possible to have operating against it, we would not require a relief valve for this cylinder.

This relief valve is usually arranged in the

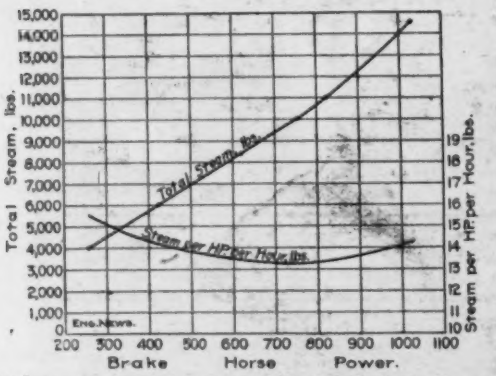


Fig. 8. Performance Curves for 400 KW. Turbine Fitted With Automatic By-Pass Valve.

Boiler pressure, 150 lbs.
Superheat, 40° F.
Vacuum, 28 ins.
Speed, 3,500 revs. per min.

body of the operating valve. When the pressure on the cylinder rises above the accumulated pressure, the relief valve is raised from its seat by the difference between the two pressures and then the water is allowed to escape from the intensified pressure into the accumulator and, of course, is not lost. These relief valves are usually provided with a ground seat; they should be kept

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TABLES II., III. AND IV.—STEAM CONSUMPTION TESTS ON WESTINGHOUSE-PARSONS STEAM TURBINES.

TABLE II.—400-KW. Turbine.

	Superheated steam and high vacuum.				Saturated steam and low vacuum		
Load	Full.	¾.	½.	¼.	Full.	¾.	½.
Load, KW.	412.5	312.8	200.7	113.35		B. HP.	
Electrical HP.	553.0	419.3	281.07	151.95	623.4	508.2	381.0
Steam pressure (gage)	150.4	152.6	152.6	152.0	142.8	144.0	144.5
Vacuum (referred to 30" barom)	28.15	28.12	28.2	28.2	26.0	26.0	26.0
Percentage of dry steam	....	....	....	....	0.989	0.989	0.9895
Superheat, degs. F.	99.6	102.3	102.0	58.6	.....	.....	.....
Total steam	7,498.0	5,797.9	4,140.0	2,745.0	9,502.0	7,992.0	6,611.0
Steam per B. HP.	12.6	12.65	12.9	14.8	15.24	15.73	17.36
Steam per E. HP.	13.55	13.83	14.7300	18.06	.....	.....	.....

TABLE IV.—1,500-KW. Turbine.

	Superheated.			Saturated		
Steam pressure gage	154.0	149.5	148.9	151.8	150.0	148.8
Vacuum (30-in. bar)	28.1	28.04	28.17	28.98	28.12	27.92
Per cent dry steam	...	...	...	97.9	97.5	98.8
Superheat, deg. F	140.6	139	138.4	...	...	...
Speed	1,500	1,500	1,503	1,500	1,502	1,500
Load, KW.	1,512	904	306	262	935	1,545
E. HP.	2,030	1,210	412	349.2	1,252	2,065
Total water per hour	25,685	17,042	8,108	7,392	19,703	30,456
Water per KW.-hr.	17.62	18.86	26.5	28.2	21.1	19.72
Water per E. HP.-hr.	12.66	14.1	19.68	21.8	15.75	14.73

Duration of test 1 hr. Observations, 5 minute intervals.

TABLE III.—1,000-KW. Turbine.

Load, K-W.	1,557.64	1,239.83	767.94	383.36
Electrical HP.	2,037.83	1,661.96	1,028.07	513.88
Throttle pressure.	145.95	144.25	147.55	155.05
Inlet pressure	137.8	106.5	72.0	38.0
Vacuum*	27.48	27.52	27.46	27.55
Superheat at throttle	28.0	28.4	27.6	29.95
Speed, revs. per min.	1,475.6	1,490.5	1,502.6	1,507.3
Total water per hr.	28,536.8	23,180.7	16,506.6	10,302.0
Water, E. HP. pr hr.	13.668	13.94	16.05	20.04

*Referred to 30" barometer.

ground in tight, for otherwise there will be a constant leakage from the accumulator pressure into the cylinder. By the proper use of relief valves it is impossible to get intensified pressure on any part of the hydraulic machine or plant and thus can be avoided many of the breakages of pipes and cylinders which are now frequent.

SAFETY VALVES.—The arrangement of the operating valves, etc., on some hydraulic plants is such that intensified pressure is unavoidable at certain times, and as the replacement of these valves by new ones is expensive, it becomes necessary to provide some means of relieving the excess pressure. This pressure usually lasts only a moment, after which the water pressure is restored to normal condition. This intensified pressure can be relieved by a hydraulic safety valve, which should be placed directly in the main line of pipe. These valves are usually arranged to be used in a horizontal position. A long lever extends outward from this valve and is weighted on the end. By moving the weight back and forth we can change the pressure at which the value will blow off. The energy of the water which escapes is, of course, lost. But as the intensified pressure only lasts for a moment, this loss is a small percentage of the power required to operate the plant. The safety valve should have a sufficient capacity to discharge the water quickly. Usually the safety valve should have the same cross-sectional area as the main line in which it is placed.

BLOW-OFF HOLES.—After all other safety devices have been supplied for the hydraulic plant, each piston or ram which does not have a positive stop should be supplied with blow-off holes. Let us take the accumulator for example. The steam valve is opened and the hydraulic pump starts to charge the accumulator. Step by step the accumulator gradually rises until it is nearing the end of the stroke. A trip now engages with the rod that leads to the regulating valve, and when the accumulator rises a little higher the valve is closed and the pumps are stopped. If this trip becomes broken or any of the mechanism in connection with the regulating valve refuses to operate, the pump will continue to charge the accumulator, and it is evident that some safety device must be provided.

Here is where one or two blow-holes should be used. They are drilled through the piston in such a position that during the ordinary stroke of the accumulator they will always be inside the gland; but when the stroke is exceeded they will pass outside of the gland and thus the water will blow off into the air. These holes should be large enough to discharge the entire supply of the pump.

In a similar manner the main piston of a flanging press should be provided with a blow-off hole. This blow-off hole, however, need not be very large, for the reason that the operator can readily

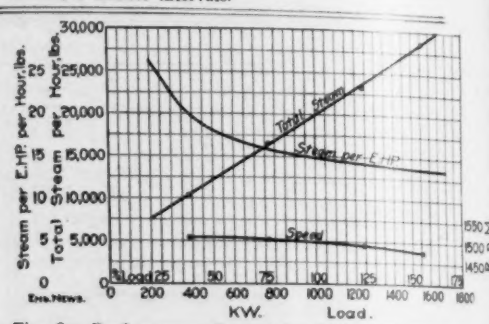

Fig. 9. Performance Curves for 1,000-KW. Steam Turbine.

Boiler pressure, 150 lbs.
Superheat, 28° F.
Vacuum, 27.5 ins.
Speed, 1,500 revs. per min.

tell when the blow-off hole is exposed, and he will then shut the water off. Then, too, there is nothing like as much danger here as in the case of the hydraulic accumulator. The main table of the press could do nothing more than move through the full stroke of the piston when the table would stop. Of course the packing and gland would have to be repaired, but it is not likely that anything would become broken.

Were the accumulator to overrun, however, the overhead work would be broken down and the massive weight of the accumulator would topple over and would very likely wreck the building and possibly destroy machinery in the vicinity. Indeed, such accidents have happened when no blow-off holes had been provided in the piston. There is scarcely an accident about a hydraulic

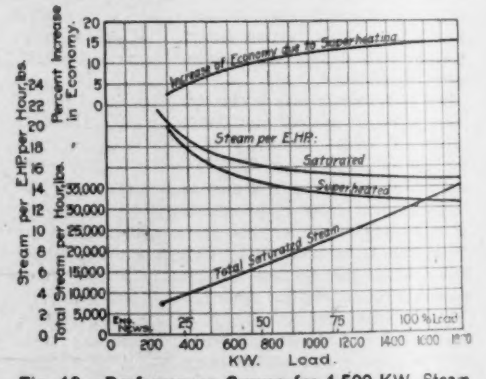

Fig. 10. Performance Curves for 1,500-KW. Steam Turbine, Showing Increased Economy of Superheated Steam.

Boiler pressure, 150 lbs.
Superheat, 0° and 140° F.
Vacuum, 28 ins.

plant that can have such serious results as that just referred to.

In a similar manner blow-off holes should be provided for the main clamping piston and the four auxiliary clamping pistons, and for the top cylinder, if there is one.

The blow-off hole should be placed about 10 to 12 ins. from the end of the stroke for accumulators or hoists. The pistons of the hydraulic press should have holes arranged to blow off at from ¼ to 5 ins. beyond the normal stroke of the machine.

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